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# Metallurgical & Chemical Engineering

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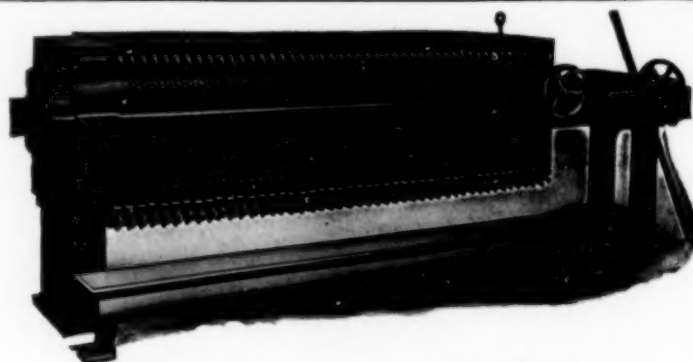
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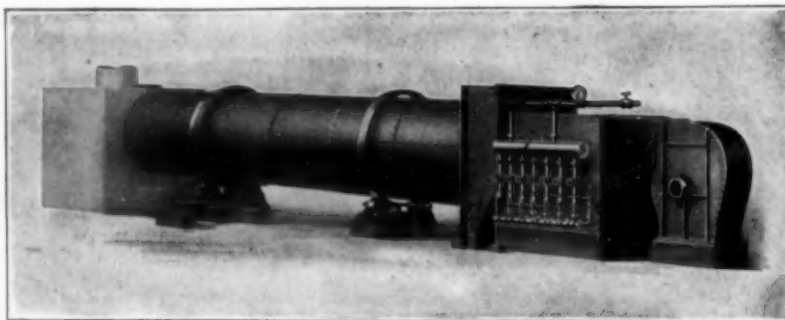
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# Metallurgical and Chemical Engineering

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## Regulation of Iron and Steel Prices

That it would eventually become necessary for the Government to regulate prices in the iron and steel industry has been apparent for some time. There is no reason to suppose that there is any serious opposition, in the minds of the steel producers, to a wise and efficient system of regulation. Certainly no such opposition has been expressed. Some articles have been published, written by novices, suggesting difficulties, and pointing out, for instance, that if the price of this commodity were regulated and the price of that commodity were not, an injustice would be done; suggesting further that the Government needs taxes, but how can there be taxes unless there is something to tax? Purposely or otherwise they overlooked the fact that there is no efficiency in robbing Peter to pay Paul and then taxing Paul. Better tax them both—collect the revenue at the source, so to speak.

It bespeaks a rather profound ignorance of the steel trade to argue that the products are so varied that an equitable schedule could not be drawn up or adhered to. What was the experience of 1908? In time of peace, with no inspiration greater than a desire for the common good; with no obligation more than a half-expressed moral one; in fear that what they did was not approved by the Government, rather than with knowledge that the Government insisted upon their doing it; with buyers only too eager to tempt them to infractions—the steel manufacturers then maintained with considerable success a price structure that was utterly contrary to the law of supply and demand. The real force at work at the time was merely the knowledge that if the market were broken all would suffer in their profits. The price structure was well understood in 1908, and it was adhered to with sufficient faithfulness to maintain the situation for more than a year.

It will be taken for granted that there can be no regulation of the price of one commodity without regulation of the price of another, or of a finished product and not of the raw or intermediate materials. A complete structure must be built up. Fair profits should be allowed, both for the economic benefit accruing and to make certain that production shall be at the maximum, for the reason that a figure which nets a profit to one mill may be ruinous to another, poorly positioned in this or that respect.

As to the relationship in prices, the experience of the past may be taken, checked by an examination into the extent to which costs have changed. The average relationship that has obtained between various commodities,



between bars and structural shapes, for instance, are well known. The differentials for size, shape, etc., in the different lines are well established. A schedule to proportion profits between the coke producer, the blast furnace and the steel maker should not be difficult. No such schedule, certainly, would produce the inequalities, indeed the iniquities, that have obtained in the recent past.

In April, 1916, there were \$45 billets with \$18.50 pig iron. Afterwards the price of billets doubled while the price of pig iron tripled. One or the other alignment was wrong. In July, 1916, there was \$2.65 Connellsville coke and \$18 pig iron. On June 30 of the present year there was \$16 coke and \$54 pig iron; triple-priced pig iron and sextuple-priced coke. Early in 1915 blue annealed sheets sold at \$4 a ton more than plates, and 28-gage black sheets at \$10 a ton more than blue annealed sheets, all of which was in keeping with the cost of manufacture. In May and June, 1916, plates and black sheets sold at the same price while blue annealed sheets sold at \$2 a ton more. Since March, 1916, wire nails have sold at a lower price per pound than the wire rods from which they are made. The keg is thrown in.

The steel industry gracefully and cheerfully, even amusedly, having "put up" with these inequalities, has no great reason to be perturbed by prospects of inequalities growing out of price regulation by the Government.

As to profits in the aggregate, the prices now quoted as representing the market are so much higher than the prices at which material was delivered in the last period for which earnings statements of the steel companies are available, that there can be no comparison. Such market as exists is practically fictitious, but it is the only market that can be quoted, and on an average the prices are fully double those at which material was being shipped in the first quarter of the year. The earnings at that time were of course quite satisfactory, seeing that they were at record rate.

The essence of price regulation, as we understand it, is to see that the ordinary buyer of steel is not penalized because the Government becomes a buyer. There can be no competition between individual and Government, as the Government sets, or will set, its own prices, but the ordinary commercial buyers would bid against each other in the effort to secure steel, and the contest would be won by the man who could boost the price the highest.

This price, in turn, would be limited only by his ability to dispose of the metal, perhaps through a long chain of "intermediates," to the ultimate consumer. The Government would collect perhaps 20 per cent of the excess profits of the steel maker, and not a red cent from the consumer of steel. Doubtless the consumer would be glad to be able to limit his liability to the aforesaid 20 per cent tax. A far better and more patriotic policy is "one price to all," neither ruinous to the individual in the purchase of his necessities, nor exorbitant to the government, that is to say, the American people, in this time of need.

### Leather Substitutes

In the present issue is a short note by Andrew H. King on the making of substitutes for leather—especially as regards the manufacture of shoes. His pronouncement that, even at present, rubber soles are better than leather, and that a wholly non-leather shoe of equal utility appears to be not only a possibility, but an actuality, should be very good news to many a suffering pater familias, standing amazed at the combined efforts of his active youngsters and the no-less active shoe market. Mr. King's views in this may be taken as authoritative, inasmuch as readers of METALLURGICAL AND CHEMICAL ENGINEERING will remember his recently published and masterly articles on various other phases of the rubber manufacturing industry.

### The Internal Combustion Engine

To the many debts we owe the internal combustion engine—not the "interior combustible" engine, as one of the Washington correspondents recently had it—there is likely to be added, according to the military experts, the debt of its winning the war for us. The science of aviation has kept ahead of the engine that has brought the flying machine to its present stage of usefulness. At the outset, the Wright brothers were able to rise from the ground merely by giving their machine its initial acceleration by means of a weight. Going still farther back, an anecdote, now first appearing in print, may be told.

The laws of the air in relation to flight were investigated exhaustively by the late Dr. Samuel Pierpont Langley, then director of the Allegheny Observatory. The experiments, by the way, were financed largely by the late William Thaw, vice-president of the Pennsylvania Railroad Company. There are few, probably, who know that the laws governing aerial flight were given to the world through the grandfather of the Lieutenant Thaw who has won laurels in France by practising the art of which his forebear had dreamed.

But to the anecdote of the internal combustion engine: Dr. Langley's experiments were conducted chiefly by means of an "aerodrome," a horizontal structure mounted on a vertical axis. At one end of the structure various pieces of apparatus were mounted in turn, to be driven against still air, so as to record the various performances of planes and propellers. To drive the aerodrome or turntable there was provided a 5-hp. gas engine of standard make. One day it became desirable to resume the outdoor experiments, and the mechanic was instructed to start the gas engine. After a time he succeeded, and the turntable was driven at the magnificent speed of six revolutions per minute. That was not enough, and while the authorities consulted, a young assistant, still in his teens and with the surplus energy of the period, seized the handle that was provided for bringing the turntable to any desired position for adjustment purposes, and drove the turntable thirteen revolutions per minute, developing four times the power of the 5-hp. engine, if the resistance



increased as the square of the speed. An expert was then summoned, who spent half a day grinding the valves. Then the engine ran half a day and stalled. The expert wanted to spend another half-day regrinding the valves, but Dr. Langley called them all off and adopted a rusty old harvester engine that happened to be in the neighborhood.

That was the status of the internal combustion engine at the time the laws of flight were being developed. About eighteen years afterwards the Wright brothers flew. They acknowledged their debt to Langley for the laws governing flight, the world had given them the engine and they had invented their stabilizing and other devices which enabled one to fly without coming to grief. Gustav Lilienthal had had many successful "glides" without a motor before he met his death in one sixteen years before the Wright brothers flew.

### Fixing Prices

Suppose we were engaged in raising potatoes. We suppose this because we have no desire to represent special interests in the matter, and we have also no intention to go into Potatocal Engineering. Let's imagine, then, that we are potato producers, and that collectively we grow spuds for the whole community. It is not a monopoly, we are rivals in business and yet potatoes are scarce. Labor is hard to obtain and wages are high. The community that supports us numbers, let us say, about fifteen thousand souls—or, rather, to keep the idea of our business in mind, fifteen thousand human stomachs. We are tenant farmers and the land all belongs to Uncle Hiram, who has stipulated in every lease that each tenant shall provide him, pro rata, with potatoes for the needs of his immediate family according to his requirement, and at his own price. We can afford to do that, especially as the old man is a bachelor and lives very simply. It is merely one of his foibles, and we count it as a negligible addition to the annual rent.

Sunday mornings after the long sermon and while the young folks are achieving merit in Sunday school, we walk around the churchyard, chew peppermint leaves and timothy stalks, and discuss potato prices. It is gossipped that one or two of the more speculative storekeepers have been bidding on the crops of certain neighbors before the harvest, and we listen with delight to the observation of some hired man who has heard tell—although he disremembers when or where—that prices for well-grown, mealy potatoes ought to reach four dollars and over a barrel by next fall. We are not accustomed to such figures; and yet, although we are not clear in our minds as to our costs, it sounds agreeable.

Then suppose something extraordinary, something utterly unexpected and undreamed of should happen: Uncle Hiram, if you please, has gone and turned Mormon; he has married a thousand wives, all of them widows, with an average of nine children each. To pile on the agony, the last, lamented husbands of Uncle Hiram's new soul mates were mostly Irish; and while

you may be a little uncertain as to what an Irishman will do under given circumstances or what his politics are, there is never any question that he will endow his progeny with an appetite for potatoes. We also learn (as in a footnote) that Uncle Hiram's price for his family requirement of potatoes for 1917 is *fifty cents a barrel*.

Now we have a situation to meet that is new and bewildering to us farmers—although it may be growing familiar to the steel men, the coal producers and some others. Our crop of potatoes was a little short even for the fifteen thousand inhabitants of the community, but Uncle Hiram's addition of ten thousand more to it, and one-half of them Irish, puts us in a quandary. We do not know how many barrels of potatoes he will require, but we can guess and we can fear; and we do know the price. We cannot agree on selling values for the rest of our product because that is against the law; it would be a conspiracy in restraint of trade. Uncle Hiram, on the other hand, does not have to agree with anybody, or conspire, or do anything but make up his mind that he will pay fifty cents a barrel, and that fixes the price for him. His action is legal. So we become worried, sorely worried.

But still worse is the fix of our neighbors who are engaged in other walks of life. We have all the potatoes there are, none may be purchased elsewhere, and there are not enough to go around after Uncle Hiram's generous two-fifths have been extracted. We do not need to do anything to bring about high prices. Our neighbors bid against each other while we hold off to observe the fireworks. In the course of time the soaring prices may assuage our distress, but in that very measure there may arise trouble in the town. The incidence of competition would shift from sellers to buyers and in potatoes there would be at once a famine and a wild market, which is always an unwholesome situation.

We have no comment to make on Uncle Hiram's conversion. We desire to avoid all discussion of religion, and if his marriage to the thousand widows was an act of faith we have neither cause nor right to complain. But his price of fifty cents a barrel for his own many potatoes seems to us to work hardship upon the rest of the community. Not only are they shortened in their supply but they are called upon to pay unheard-of prices. They are crippled in their various walks of life. They are injured in business and in health and in the end they may be unable to pay rent as promptly as they did—if indeed they can pay it at all—and Uncle Hiram, who owns everything, needs rents now more than ever before.

It seems to us that it would have been better if the old gentleman had fixed his price at something nearer the market. Some of his wives might be thrifty, and feed thinner. Others might cook rice. And the community would not have to pay so much to us very much frightened farmers, who, being particularly anxious to cover our expenses lost in the deliveries to Uncle Hiram's step-flock, would err on the side of caution.

## Readers' Views and Comments

### Magnetic Separation of Tungsten Ores

*To the Editor of Metallurgical & Chemical Engineering*

SIR:—In your June 1 issue, page 632, mention is made under "Some Uses of Magnetic Separators," that magnetic separation is not used in the Netherland District of Colorado for the treatment of tungsten ore.

As the undersigned is perfectly familiar with conditions in that locality, he wishes to advise you that this is not literally true, as hundreds of tons of these tungsten concentrates and middlings are annually treated over the Wetherill magnetic separator. In some cases concentrates have been increased from 40 to 65 and 70 per cent tungstic acid, and where pyrite is associated with ferberite, magnetic separation is indispensable.

A large three-magnet separator of the Wetherill type is at present operating in Boulder.

During the last three or four months the writer has tested hundreds of tungsten ores magnetically and success was obtained on practically all of them. It was proven that the magnetic separation was a commercial success and in several instances the only salvation in saving the values.

In the garnetiferous scheelite ores of Nevada and California, difficulty of separating garnets from scheelite was encountered by wet concentrating methods. The trouble is obviated by the use of the Wetherill magnetic separators which have eliminated all of the garnets and raised the grade from 10 to 25 per cent. Considering the present high bonus for purity, magnetic separation speaks for itself.

ARTHUR C. DAMAN.

Denver, Col.

### Guayule Rubber

*To the Editor of Metallurgical & Chemical Engineering*

Sir:—With reference to the article by Andrew H. King on "Guayule," in your issue of Nov. 15, 1916, and on "Rubber Planting," in your issue of Jan. 15, 1917, the following notes from my experiences may be of interest.

In November, 1904, I operated at Torreon, Mexico, the first plant extracting rubber from guayule by mechanical means, as per my U. S. patent No. 779,696, Jan. 10, 1905, Mexican patent No. 4079, Oct. 22, 1904. This was the birth of the guayule industry. Several smaller concerns, established later, paid royalties, but the more important ones infringed upon my patent rights.

Several years ago I visited the University of Arizona, at Tucson, and there saw an experiment in progress with growing about 1/2 acre Guayule. These plants were subjected to irrigation. I called their attention to the fact that most of the plants in sight were Mariola instead of Guayule, but I noticed several well and perfectly-formed guayule plants, and therefore came to the conclusion that Guayule can be grown successfully.

Over five years ago I prepared addresses on "Rubber Planting in the United States." I repeat what I then stated, that Guayule and Landolphia, "the creeper," having rubber in threads within the bark, can be grown in many sections of California, on lime formations,

close to transportation, and purchasable at \$2 to \$4 per acre. I am informed that the Intercontinental Rubber Co. are planting an extensive tract with Guayule in Arizona. Excessive heat, drought, or cold is not detrimental to Guayule. It is a winter plant, and the International Rubber Co. is following a sound pursuit. There are ways to plant from the seed at a nominal cost; the advantage of planting shoots is that it results in a year's saving in the time necessary before it becomes of sufficient size for use.

Latex-holding Florubanda, a creeper holding a fair quality of rubber, and Chitte trees, such as are abundant on the west coast of Mexico, producing rubber, can be sown in California. There also exist in Utah or Idaho "Indian Roots," and in California a "Rattlesnake shrub," which grows abundantly, 4 to 10 ft. high, and contains 3 to 4 per cent rubber.

There never need be a scarcity of good quality hard rubber in the United States, as such can be produced to perfection by pulverizing any rubber-containing shrub, adding thereto sulphur (or in some instances litharge) and vulcanizing the mass. I hold patents on this process, but owing to the cheap compounds being used at present the advantages I offer are meager.

F. EPHRAIM.

San Francisco, Cal.

### Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 24, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

### Western Metallurgical Field

#### Molybdenum

According to an article by E. P. GRANT, in the Bulletin of the Canadian Institute, June, 1917, the International Molybdenite Co. treated 2350 tons of ore containing approximately 60,000 lb. of MoS<sub>3</sub> at their various plants. The ores were shipped from properties in Ontario, Quebec, and British Columbia, about half of the total tonnage treated being custom ores, while the rest came from the company's own properties. The ores from the different localities are dissimilar in character, some containing iron sulphides in large amounts and some being very micaceous. The ores from British Columbia seem to be freer from deleterious substances than those from Ontario and Quebec, although the flakes of molybdenite are very much smaller, and in some instances are nearly amorphous.

The ores are treated at the concentrator at Renfrew, which was completed in September, 1916, by a process developed after eighteen months' experimentation. On entering, the ore goes to a jaw crusher, thence to a



gyratory crusher, and thence either to storage bins or to a rotary drier. The flow up to this point is effected by gravity. The material is then raised to the top of the mill, where it is delivered to a large set of rolls and screens, the undersize dropping on a conveyor belt leading to storage bins in the flotation department. The oversize is raised by a bucket elevator to a second set of rolls and screens, the undersize again being sent to the storage bins in the flotation department. With ores containing large flakes of molybdenite a fairly good concentrate may be obtained by proper screening practice. As a rule, this concentrate is taken to sampling rolls to be cleaned, while the undersize goes to the flotation department. An automatic sampler is placed immediately below the gyratory crusher, and the bulk sample thus produced is reduced to an assay sample in the usual manner.

The flotation department adjoins the mill, and is housed in a building 90 ft. long by 30 ft. wide. It contains nine flotation machines, 6 ft. wide by 18 ft. long. The chutes from the storage bins mentioned above are 12 ft. above the floor level, and discharge into a traveling hopper of 1200 lb. capacity, and which in turn discharges into 2400-lb. hoppers feeding the flotation machines. The material discharges from the feed hoppers through adjustable openings to the feed boards of the flotation machines. The flotation machines have a capacity varying from 500 to 1500 lb. per hour, depending upon the character of the material treated, the finer the material the lower the capacity. The size of material floated also varies with the nature of the ore. Usually, a product through 20 mesh gives satisfactory results, but it has been found necessary at times to crush some ores through a 60-mesh screen. The concentrate is collected at the end of the machine, dried on steam driers, and is then ready for shipment; or, if low grade, is given a special treatment. The tailing is carried to the dump by means of waste water.

It has been demonstrated that it is most economical to produce a product ranging between 60 per cent and 70 per cent  $\text{MoS}_2$ , and this is therefore the company's aim. The mill was designed to handle 100 tons of ore per day but at present its capacity is from 50 to 60 tons. The following table gives an idea of the percentage extraction. The tonnage put through was small and the extraction a little above normal.

Day	Lb. Floated	Per Cent $\text{MoS}_2$ in Heads	Per Cent $\text{MoS}_2$ in Tails	Per Cent Recovery
Oct. 17.....	23,400	2.29	0.24	90
Oct. 18.....	22,200	1.16	0.17	90
Oct. 19.....	15,000	1.64	0.16	90
Oct. 20.....	19,800	1.66	0.21	87
Oct. 19.....	28,800	1.35	0.26	80
Oct. 20.....	28,600	1.71	0.45	71
Oct. 20.....	28,200	1.74	0.24	86
Oct. 20.....	20,400	1.37	0.31	80

The concentrate from the mill is shipped to the company's refinery at Orillia, which produces ferro-molybdenum, molybdic acid, and ammonium molybdate of both commercially and chemically pure quality. The first stage of the process is to convert the concentrate into crude ammonium molybdate. This is then charged into an electric furnace with the requisite amount of iron. The furnace department has a capacity of two tons of ferro-molybdenum per 24 hours. The furnace product contains 70 per cent to 76 per cent metallic molybdenum, less than 0.1 per cent sulphur, no phosphorus, no copper and about 3 per cent carbon. All the ferro-molybdenum

produced at present is sold to the Imperial Munitions Board.

The chemical department produces molybdic acid (85 per cent and 99 per cent), and ammonium molybdate. At present only the chemically pure materials are made. Some research work has been done in this department in connection with producing molybdenum dyes and molybdenum wire. The chemically pure molybdic acid and ammonium molybdate are supplied for laboratory purposes to Canada and the United States.

The company produced ferro-molybdenum, molybdic acid and ammonium molybdate valued at \$110,000 in the year ending on Dec. 31, 1916. However, these figures are not representative of actual operations as ferro-molybdenum has only been produced since October, 1916. At present the production will amount to \$500,000 per annum, and is increasing rapidly. These statements are of interest, as this concern is unique as being one which mines and purchases molybdenum ores, operates its own concentrator, uses its own process of concentration, refines all the products from its concentrator, and at the same time produces chemically pure reagents.

### Labor Troubles

The whole Rocky Mountain district seems to be having an epidemic of strikes. None of these concern a very large body of men, but rather are local infections of rather limited extent. The operations of all allied industries, however, may be seriously curtailed by the strike of a few electricians or engineers. On the other hand, internal dissensions among the unionists over jurisdictional or other rights are a prolific cause of trouble. In their entirety it seems probable that a large decrease in metal production will result.

### The Colorado Mill Operators' Association

A new society of the above name has been organized, and held its first regular meeting on June 30, at the Brown Palace Hotel, Denver, Col., presided over by the president, Judge E. A. Colburn. The society was organized with the hope that other States might follow the lead, also forming such associations, all of them interested in milling practice, which will then unite, becoming a strong and efficient national organization, which, as a whole, will be capable to consider matters of national import in the field of milling. Mr. G. L. Nye, H. C. Colburn and J. M. McClave presented interesting papers on flotation, while J. M. Hyde discussed informally the recent decision in the suit of the Minerals Separation Limited vs. Hyde. Mr. J. F. Collbreath, secretary of the American Mining Congress, also spoke on the work of his organization.

### Recent Development in the Missouri, Kansas and Oklahoma Zinc Fields

The most noteworthy developments are the strikes made in the Miami field. Quite a few mills in the Webb City and Cartersville districts are now being dismantled and are being shipped into the Kansas and Oklahoma fields. The price of blende at present being \$75.00 for the highest grade, ranging down to \$60.00 for second and third grades, makes it rather hard for the producers in the Webb City and Cartersville fields to produce blends profitably. This is also true of some of the South Joplin Mines, since the average cost of mining and milling in these dis-



tricts is from \$68.00 to \$75.00 per ton of blende. However, there are quite a few mills operating in the older fields, some are fairly profitable and some are merely hanging on, but the operations are gradually being reduced to the better producers.

The ores in the Miami district, while very rich, are not quite so freely liberated as the ores in the Joplin fields, requiring a finer grinding.

The adoption of table concentration in preference to the old-fashioned sand jig, is very noticeable in the entire district, while flotation is gradually but surely coming. Several small installations are floating their ores and several larger mills are under construction. The flotation concentrates, however, are causing difficulties, particularly those from the Miami field, where the lead in the original ore is often quite high. As is commonly the case with most complex ores and particularly with ores from the Joplin district, lead is concentrated in the finer sizes. For this reason the flotation concentrate may contain from 10 to 20 per cent lead with a zinc content of 40 to 45 per cent, which naturally requires a subsequent separation of lead and zinc. Of course the smelters do not favor an extremely fine concentrate, and as a whole, this particular type of product will require some new metallurgical treatment.

One concern in Webb City is now conducting extensive research work on the manufacture of zinc dust, and has produced some dust showing a precipitating efficiency of 75 per cent working on silver cyanide solutions. This might open a welcome outlet for some of the flotation concentrate which at present is otherwise not very desirable.

#### Flotation

Although only a few years old, the flotation process has risen to be the main system for concentrating ores. According to Prof. Francis A. Thomson the flotation plants of America are handling 30,000,000 tons of ore each year, while the world's capacity is 50,000,000 tons. Flotation leads all other methods of treatment in America, as is shown in the following table:

Method	Tons Per Year
Flotation	30,000,000
Copper smelting	25,000,000
Gravity concentration	25,000,000
Gold and silver milling	15,000,000
Lead smelting	5,500,000
Copper leaching	2,000,000
Zinc smelting	1,000,000

Approximately the same ratios apply to the world production, except that the proportion treated by copper smelters will be less and by gold mills greater than here given. It would be easier to enumerate ores which are not being floated than to list the other category. Gold, silver, copper, lead, zinc, molybdenum, cinnabar, tungsten and many other ores are being successfully handled, and it is proposed to use the process for the recovery of substances as far apart as flour-gold and anthracite coal. It looks as if there may be keen competition between cyanidation and flotation in the treatment of gold and silver ores during the next few years, with the odds apparently in favor of cyanide for gold and of flotation for silver.

It is only natural that a process which has arisen to such eminence in the short space of six years should excite universal interest among miners, millmen and

metallurgists, not to mention the legal profession. The very evident ease and economy with which it makes very difficult separations commends it to the practical mill man, while its unexplained *modus operandi* irresistably attracts the scientific metallurgist to its mysteries.

Unfortunately, the progress of the flotation process has been marred by unending litigation between the owners of a number of the basic patents and various concentrating mills who have either wittingly or unwittingly committed infringements. It is notorious that a very large percentage of mill operators have assumed an openly hostile attitude toward the Minerals Separation Company which is unfortunate in the extreme, but which they aver is entirely due to "bulldozing" and other "armstrong" methods of the holding company. It is a matter of universal regret that it seems impossible to suppress recrimination leading even to actual war during the development of this process, which has such wonderful potentialities.

#### Company Reports

**1916 Report of Camp Bird Limited.**—During the year 26,237 tons (wet weight) of ore were treated at the stamp mill and at the cyaniding plant. This tonnage yielded \$791,749.55, an average of \$30.92 per ton, as compared with \$29.47 for last year. The running-time in both mills was 331 days, 1 hour, 50 minutes, based on a maximum of 25 stamps dropping for 24 hours per day until the 11th of May, and beginning May 12th a maximum of 20 stamps dropping 8 hours per day until the 24th of June, when 20 stamps started dropping 24 hours. There was a saving of 97.13 per cent of the gold in the crude ore, and a saving of 95.19 per cent in the combined value of gold and silver. Of the total value extracted, 63.88 per cent was extracted by amalgamation, 31.63 per cent by concentration and 4.49 per cent by cyanidation.

**Annual Report of the Utah Copper Company for 1916.**—The total quantity of ore milled at the Magna Plant was 6,143,500 tons, being an increase of 910,200 tons as compared with 1915. At the Arthur Plant 4,850,000 tons of ore were milled.

The average grade of ore treated at both plants was 1.435 per cent copper as compared with 1.434 per cent copper for 1915. The average recovery at both mills was 62.34 per cent, corresponding to 17.90 pounds of copper per ton of ore, as compared with 64.13 per cent, or 18.39 pounds of copper per ton for the previous year. The low extraction is mainly due to the large tonnage of ore treated, and in small part to the presence of unrecoverable carbonates.

The cost of milling at the Magna Plant was 35.35 cents per ton and at the Arthur Plant 40.94 cents per ton as compared with 30.91 cents and 39.02 cents, respectively for the year 1915. The average cost of milling at both plants was 37.82 cents per ton as compared with 34.02 cents for 1915. The increased cost was due to higher costs of labor and supplies. In fact, the cost per ton should have been considerably lower than the cost for the previous year on account of the greater tonnage treated.

The total gross production of copper contained in concentrates was 196,752,631 pounds, and the average grade of concentrates was 18.71 per cent copper. The corresponding figures for 1915 were: Copper in con-

concentrates, 156,207,376 pounds; concentrates contained 19.17 per cent copper. The copper contained in direct smelting ores amounted to 664,849 pounds. The value of gold and silver recovered from the copper amounted to 0.653 cents per pound of copper treated.

During the course of the year the feeders and conveyors in the coarse crushing department of the Magna Plant were remodelled. The feeders in the fine crushing department of the same plant were also changed. At the Arthur Plant, the electric sub-station was remodelled, some new equipment for the foundry was purchased and the main tunnel for tailings and concentrate launders was enlarged. Near the end of the second quarter, designs were sufficiently advanced to start construction upon the additional equipment for the purpose of improving recoveries, and increasing the capacity of the mills. Three of the thirteen sections of the Arthur Plant were practically remodeled before the end of the year but were not put in operation, due to unavoidable delays in the receipt of some parts of the equipment. Similar improvements will be continued at this plant and started at the Magna Plant. The improvements consist principally in adding to the fine grinding and concentrating equipment. When completed it is expected that the combined capacity of the plants will be 40,000 tons per day, of which the Arthur Plant will handle 16,000 tons and the Magna Plant 24,000 tons.

Construction work on a new leaching plant was started early in August, 1916. It is contemplated to construct 12 concrete leaching tanks. The twelve tanks will have a capacity of from 3000 to 4000 tons per day. The plant is so situated and planned that its capacity can readily be increased to 10,000 tons daily. The material to be treated at this plant consists of the oxidized and partially oxidized capping overlying the sulphide ore bodies. It is estimated that 40,000,000 tons of this material will be available for treatment. The copper content of this oxidized ore body is estimated at 13 pounds per ton of ore. Experiments indicate that about 10 pounds of the copper content is soluble in dilute sulphuric acid. Results of tests show that approximately 9 pounds of copper can be recovered from one ton of capping. The net cost of treatment will amount to about 9 cents per pound of copper recovered.

### The Engineering Council

On June 27 the first meeting of the Engineering Council was held. This body is a department of the United Engineering Society and has recently come into being as a medium of co-operation between four national engineering societies. The function of the Council may perhaps best be described by the following extract from the by-laws of the United Engineering Society: "The Council may speak authoritatively for all member societies on all public questions of a common interest or concern to engineers."

The Council is composed of twenty-four members, five being appointed by each of the four founder societies and four by the United Engineering Society. Its present membership follows:

American Society of Civil Engineers.—J. F. Stevens, (Chas. Warren Hunt), George F. Swain, F. H. Newell, Alex. C. Humphreys, F. D. Galloway.

American Institute of Mining Engineers.—P. N.

Moore, S. J. Jennings, B. B. Lawrence, J. Parke Channing, Edwin Ludlow.

American Society of Mechanical Engineers.—I. N. Hollis, Chas. Whiting Baker, John H. Barr, A. M. Greene, Jr., D. S. Jacobus.

American Institute of Electrical Engineers.—H. W. Buck, E. W. Rice, N. A. Carle, P. Junkersfeld, C. E. Skinner.

United Engineering Society.—Clemens Herschel, B. B. Thayer, I. E. Moulthrop, Calvert Townley.

At the organization meeting held in the rooms of the American Society of Mechanical Engineers on June 27 the following officers were elected:

President, I. N. Hollis; Vice-Presidents, H. W. Buck, George F. Swain; Secretary, Calvert Townley; Executive Committee, the four officers named with J. Parke Channing and D. S. Jacobus.

The council discussed at length ways and means by which the founder societies through the Council may be of use to the nation. The unanimous desire to help the Government in the prosecution of this war resulted in a resolution instructing the executive committee to co-operate with the government in procuring the services of engineers, also the appointment of a committee of three consisting of Messrs. H. W. Buck, A. M. Greene, Jr., and Edmund B. Kirby, to consider the best means of utilizing the inventive ability of members of the founder societies.

The secretary was instructed to inform all Government Bureaus that might be interested in the organization of the Engineering Council and its desire to be of assistance.

### St. Louis Meeting of the American Institute of Mining Engineers

#### Oklahoma Oil Fields

Those attending the annual meeting of the American Institute of Mining Engineers will be interested in viewing, among other things, the enormous development



VIEW OF GLENN POOL FIELD NEAR NEW TANEKA, SAID TO BE THE WORLD'S LARGEST OIL FIELD

of the oil resources of Oklahoma. The magnitude of the operations springing up almost over night may be realized by the accompanying view in the Glenn Pool Field.



## Work of the Council of National Defense

The first official comprehensive statement of the organization and accomplishments of the Council of National Defense and its Advisory Commission was incorporated in a report from the Director of the Council and Advisory Commission, Mr. W. S. Gifford, to the chairman of the Council, Secretary of War Baker. The length of the report (48 typewritten pages) is indicative of the enormous amount of work accomplished. The great value of the accomplishments to date can be gathered from the introductory statement giving a brief summary of the work as follows:

The mobilization of the 262,000 miles of railroads of the country for the Government's defense.

The close-knit organization of the telephone and telegraph companies of America to insure to the Government the most rapid and efficient wire communications.

The settlement of the recent threatened national railroad strikes.

The very general acceptance by labor and capital of the suggestion of the Council that existing labor standards should not be changed until the need for such action had been determined by the Council with the steadying influence on industry growing out of such action.

The procurement of 45,000,000 lb. of copper for the uses of the Army and Navy of the United States at less than one-half of the then current market price—a saving to the Government of approximately \$10,000,000.

Similar accomplishments as to steel, zinc and aluminum.

The completion of the inventory, for military purposes, of 27,000 American manufacturing plants.

The money saving to the Government, through appointment over the country of committees of business men to assist the quartermasters' department of the Army in the economical and efficient purchase of supplies.

The saving to the Government of millions of dollars by the proper co-ordination of purchases through the agency of the General Munitions Board of the Council of National Defense.

The creation, under the medical section of the Council, of a General Medical Board, consisting of many of the most highly qualified surgeons and physicians of the country.

The selection by the same section of thousands of doctors specifically qualified for membership in the medical officers reserve corps, and the standardization, far on its way to completion, of surgical instruments and supplies.

The creation by the Council of the Aircraft Production Board, which is setting out to make 3500 airplanes and to train 8000 aviators this year.

The very definite results obtained by the Council's Committee on Coal Production in the procurement and expeditious shipment of coal, both in the civilian and federal interests.

The successful initiation of a movement to co-ordinate activities on the part of the States of the Union for the national defense, brought to a clear and workable focus by the conference of States held recently in Washington at the call and under the auspices of the Council.

The organization of a railroad committee to send to Russia; and

The enlistment of reserve engineer regiments to aid in rehabilitating the railroads of France.

A list of the members of the Council and its Advisory Commission, and of the various sub-committees, was given in our issue of June 1, 1917, page 633.

*General Munitions Board.*—On April 9, 1917, the General Munitions Board began its work under orders of the Council. The chairman of this board is Frank A. Scott, vice-president of the Warner & Swasey Co. The board has co-ordinated the department buying of the Army and Navy in order to avoid competition in the various departments. It has made investigations and recommendations and drawn up contract forms in the purchase and manufacture of small arms, artillery, gun forgings, gun carriages, shells, cotton duck, raw materials, etc. It has also advised on cantonment work, optical glass for military instruments and gages. It has made adjustments with the British Government and compiled statistics of manufacturers. It has saved the Government considerable money through the co-ordination of purchasing.

*Munitions Standards Board.*—This board was created on March 20, 1917, by the Council.

Careful investigations have been made and meetings held with manufacturers of shells, machine guns, etc., with resulting introduction of modifications in specifications and design to permit of greater quantity of production. A comprehensive list of manufacturing concerns who had been and were manufacturing munitions for the Allies was compiled for confidential use and the productive capacity of the country along these lines was developed and tabulated.

*Aircraft Production Board.*—This board was organized to advise on design, specifications, standardization and production of aircraft and to co-operate with the Army and Navy in furthering the science of aviation. The board has worked on training plans, has assisted in starting schools, has adjusted the patent situation, investigated production facilities, developed plans for making training planes and battle planes and considerable other work. It is pushing the production of aeroplanes as fast as possible.

*Inventions (Naval Consulting Board of the United States).*—The Naval Consulting Board of the United States, headed by Thomas A. Edison and composed of eminent scientists and inventors, acts as a board of inventions for the Council of National Defense. The board is now, and has been for some time, actively engaged in the investigations of plans to counteract the submarine menace.

*Commercial Economy Board.*—The duties of this board, under the chairmanship of A. W. Shaw, are to ascertain how commercial business may best meet demands made upon it by the war, and how men, supplies and equipments now employed in trade can be made available for the needs of the Government without impairing the essential services of trade and without unnecessary hardships to the public at large.

The board is investigating retail delivery service, economies in trade and manufacturing, such as wrapping, packing, the effect of diversion of certain raw materials to the production of military supplies, etc.

*Committee on Coal Production.*—This committee, recently formed, has been active in strike difficulties,



transportation problems and Government and domestic supplies.

**National Research Council.**—At the request of the Council of National Defense the National Research Council is maintaining in Washington an active committee under the direction of Dr. George E. Hale and Dr. R. A. Millikan for the purpose of co-operating with the Council of National Defense in matters pertaining to scientific research for the national defense. The chairman of the Chemistry Committee of the Council is Dr. M. T. Bogert, who also has his office in Washington.

The National Research Council is at present engaged in such investigations as the study of devices for detecting completely submerged submarines and mines; range finders of various types; devices for detecting invisible aircraft and sapping parties; improvements in wireless apparatus and other instruments used with aircraft; military photography, prevention of corrosion and electrolytic action on the hulls of vessels; balloon fabrics; fabrics for army slickers; new explosives; and utilization of wastes and by-products. The committee on nitrate supply appointed at the request of the Secretary of War to consider the process to be used by the Government in its plant for producing nitrates for explosives and fertilizers, has submitted a full report. Through the co-operation of the Bureau of Standards and the geophysical laboratory of the Carnegie Institute with glass manufacturers, the problem of supplying the optical glass for military purposes is well advanced toward solution. Another vital matter which is being fully investigated is the study of noxious gases and methods of protection. Committees of or associated with the Advisory Commission, viz.: Committees on Transportation and Communication, Telephone and Telegraph, Supplies, Raw Materials, Minerals and Metals, Labor, Munitions and Manufacturing, Engineering and Education are all doing noteworthy work. The details of some of this will be given in a later issue. Lack of space prevents its publication here.

### American Society for Testing Materials

Annual Meeting at Atlantic City, June 26-30, 1917

Undoubtedly the most important paper presented at the meetings of the American Society for Testing Materials, of which the first day's proceedings were reported in our preceding issue (this volume, page 11)—was that by Dr. Charles W. Burrows of the United States Bureau of Standards. He had been working for some time to determine whether there was a relationship between some easily-determined magnetic or electrical property of the metal with its homogeneity or constancy of physical properties. He now says that "the fundamental fact that there is a definite relation between the magnetic and mechanical properties of steel is so well established that the successful application of magnetic analysis to commercial testing is assured." He admits that apparatus for the particular case must be developed and operators trained, but "the difficulties presented are not excessive."

It is planned to publish this paper in a subsequent issue, and further comment is reserved until that time.

A subcommittee prepared tentative specifications which may be regarded as useful suggestions to metallurgists and microscopists in general, on proper metallo-

graphic practice. Their recommendations for this work are as follows:

The standard magnifications for making micrographs of steel and ferrous materials should be: 50, 100, 250 and 500 times, and for non-ferrous metals should be 25, 75, 150 and 250 times.

For general use in society reports and for showing the grain size of ferrous materials use a magnification of 100 diameters, and of copper and copper alloys, 75 diameters. Reproductions of micrographs in publications should be made of the exact standard magnifications. If micrographs submitted for publication are not, they should be enlarged or reduced to the nearest standard size, and should be printed in the form of squares in order to conserve space. With each micrograph should be printed an explanatory title, together with actual magnification, etching medium, treatment, etc., indicating what the author intends to show, so that it will not be necessary to search the text for general information.

Magnifications	Lens	Ocular
20 to 50 30 to 70 75 to 150 250 to 500	Microplaner or microtessar 32 mm. 16 mm. Apochromatic 4 mm.	None Huyghenian ocular x5 Huyghenian ocular x5 Projection ocular

All objectives should be corrected for uncovered objects, and the bellows extension regulated to give the exact magnification desired. It should be borne in mind, however, that increasing the magnification by increasing the length of the camera bellows adds nothing to the detail of the micrograph. This depends entirely upon the resolving power of the objective used.

Important suggestions as to the determination of grain size are as follows:

(a) *Alloys consisting of but one type of crystals* (e. g., copper, alpha brass, etc.): In counting individual grains the original crystal, including the twinned layers, should be called one grain.

(b) *Alloys consisting of two metallographic components* (e. g., steels, Muntz metal, etc.): The original grain which has given rise to the aggregation of the two components should be taken as the unit when determinable, and the individual component in other cases. When grain size is included in actual specifications, the term should always be defined.

For measuring grain size, two methods are recommended, depending upon the condition of the material:

(a) *For material in which the grains are equi-axed* (e. g., most metals in the cast and in the annealed state): The planimetric method as modified by Jeffries is recommended for use as being very accurate and rapid. It is recommended that the circular area used should always include at least 50 grains.

(b) *When the grains are not equi-axed* (e. g., in strained materials): Heyn's intercept method should be used, the average grain size being determined by counting the number of grains at a given magnification along a line of known length on two axes at right angles to each other, one axis being parallel to the direction of rolling. In some cases a third count along a line perpendicular to the other two may be desirable. This will necessitate the preparation of another polished surface.

The grain size as determined by the planimetric method should be expressed as the number of grains

per unit area (square inch or square centimeter). This may also, but less preferably, be expressed as the average grain area; or the average linear dimension of the grain may be given. The grain size as determined by the intercept method should be expressed by giving the average number of grains per linear unit in the two directions; or the average number per unit area together with the ratio of length to breadth of grain ( $L/B$ ) may be given.

If grain size is to be included in specifications, it should be expressed as the maximum or minimum allowable as determined above. It is recommended that only in extreme cases should grain size be made the sole basis of rejection of material.

In the discussion of the report, it was pointed out by **George F. Comstock**, Titanium Alloy Mfg. Co., Niagara Falls, N. Y., that there should be separate standards for ferrous and non-ferrous metals and emphasized that 75 diameters, though possibly applicable to rolled non-ferrous material, was not satisfactory for cast non-ferrous material. Objection to the scale of magnifications recommended was made on the basis that the scales obtainable with many commercial pieces of apparatus, modified to suit the proposed standard of 50, 100, 250 or 500, would in some cases result in loss of definition or in others unnecessarily limit the field photographed.

The ever present question of **corrosion** was again up for consideration. During the discussion, **Mr. R. B. Carnahan, Jr.**, second vice-president American Rolling Mill Co., Middletown, Ohio, deplored the lack of a real measure of corrosion. A metal roof is removed because of a few leaky holes, though many parts of it show no corrosion at all. To describe corrosion in terms of a loss of weight in an accelerated test is fallacious. The failure of a steel plate in spots may be due, he held, to flaws resulting from steel cast in a dirty or moist mold, from some malpractice in the soaking pit, from seams produced in rolling; and many of these mill influences may be worse than chemical shortcomings.

**Mr. W. R. Webster** submitted a short illustrated paper showing the lack of connection between interior surface defects on brass condenser tubes and corrosion therein. It is the belief of some engineers that defects on the interior surfaces of brass condenser tubes act to accelerate corrosion and that accordingly their presence even to a small degree should not be tolerated. Extended observation on the part of the author has failed to furnish a basis for such a belief. It has been found that tubes containing such interior defects are no more subject to corrosion than those which were free from them.

It has further been observed that there is no tendency whatever for areas of corrosion to localize in the vicinity of such defects. Moreover, many cases have been found in which severe pitting had occurred in the vicinity of such defects, but absolutely no tendency of the corroded areas to follow along the lines of defect has ever been noticed.

A recent case of severe corrosion was observed which furnishes very strong evidence that no such connection exists. The tubes had been in service in the condenser of a large stationary plant for about six months and then removed because of perforations caused by local corrosion on their interior surfaces. Of a lot of eleven tubes, eight were found to be absolutely free from surface defects in the vicinity of the corroded areas.

Particular attention was called to the fact that even where a corroded area crosses a defect, no tendency whatever for the corrosion to follow the defect is observable. In most of the samples the corroded area was confined to a distance not over 4 in. from the inlet end of the tube, the remainder of the tube being as free therefrom as when first made.

**H. A. Gardner**, assistant director of the Institute of Industrial Research, read a paper describing a series of exposure tests which were made on paints applied to large-size metal plates, 24 by 36 in., with the object of determining what grade of pigment is best suited for use as a priming coat.

After three years' exposure, the panels to which had been applied a single coat of red lead containing a substantial percentage of litharge were in better condition than the panels painted with a single coat of highly oxidized red leads or iron-oxide paints. Those portions of the panels to which had been applied two coats of paint, gave substantially the same relative results.

The paints used were reserved, examined and analyzed after storage for three years. The highly oxidized red leads in general were not in superior condition to the others, except in one instance where a red lead of low specific gravity was used. The other paints were soft and in excellent condition.

Much has been said regarding the hardening of red lead in packages, especially if the red lead should contain any pronounced percentage of litharge. It is interesting to record the condition of the paints used in these tests after standing for three years in half-gallon cans. When the cans were opened, some of the clear oil was removed from each package and ashed to determine the amount of pigment that had gone into solution. The results of the tests indicate that red leads high in lead tetroxide are quite as soluble in linseed oil as red leads high in lead monoxide.

The results obtained in the storage tests indicate that some chemical action takes place other than that to be accounted for by the formation of lead linoleate, since the latter is soft rather than hard. The writer is of the opinion that the chemical reactions which are partly responsible for the hardening of red-lead paints, cause the formation of lead glycerinate, a substance that is recognized as one of the hardest and most durable cementing materials. It is obvious, therefore, that linseed oil having a high acid number and often containing a substantial amount of free glycerin is dangerous to use in making red-lead paints that are to remain in packages for a long period previous to use.

**Noteworthy papers** which might also be mentioned were "A Method for Studying the Effects of Temperature Upon the Physical Condition of Asphalts, Waxes, Etc.," by **J. A. Capp** and **F. A. Hull**; "Determination of Absolute Viscosity by the Saybolt Universal and Engler Viscosimeters," by **Winslow H. Herschel**; "Light Versus Heavy Reductions in Cold-Working Brass," by **W. Reuben Webster**.

The Committee C-8 on "Refractories" presented a very interesting report on the testing of refractory materials under load at high temperatures, and on testing the slagging action of refractories. **C. E. Nesbitt** and **M. L. Bell** presented a paper on "Some Suggested Improvements in the Manufacture of Silica Brick," all of which we hope to publish in extenso in a following issue.

## The Action of Aluminium Chloride on Pure Aromatic Hydrocarbons<sup>1</sup>

By Robert J. Moore and Gustav Egloff

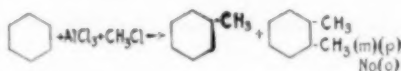
Contribution from the Havemeyer Chemical Laboratory,  
Columbia University, No. 298.

In a general study of the formation of benzene and toluene resulting from the action of temperature and pressure upon paraffin,<sup>2</sup> naphthene<sup>3</sup> and aromatic<sup>4</sup> base oils, it seemed desirable to work out the action of aluminium chloride upon pure aromatic compounds with a view to determining the yields of benzene and toluene, this information then to be applied to commercial sources which would contain in large quantity the aromatics studied. The aromatics studied for this preliminary information with respect to the course of reaction were benzene, toluene, xylenes, cumene and cymene.

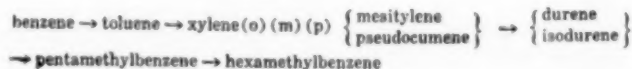
A review of the literature indicated a number of reaction products resulting from the action of aluminium chloride upon pure aromatic hydrocarbons, but there was no report of the percentage yields of benzene and toluene resulting. The following communication covers the percentage yields of benzene and toluene resulting from the action of aluminium chloride upon the aromatics studied, benzene, toluene, xylene, cumene and cymene.

### HISTORICAL REVIEW OF THE LITERATURE

It is well known that the action of methylchloride and aluminium chloride upon benzene builds up higher methyl derivatives of benzene. Ador and Rillet<sup>5</sup> by passing methylchloride in the presence of benzene and aluminium chloride showed that the reaction took place as follows:



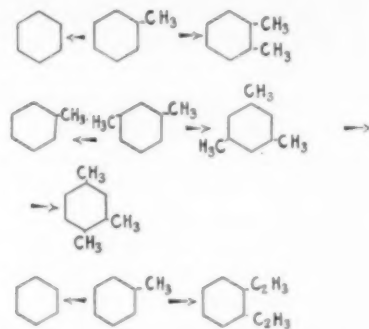
Jacobsen<sup>6</sup> a few years later carried the methylation of benzene much further in the presence of aluminium chloride. He was able to replace each hydrogen atom of the benzene ring by a methyl group clear to hexamethylbenzene. He found the course of reaction to be as follows:



If reversibility of the reaction is assumed, the splitting off of alkyl groups from a benzene nucleus and the building up of higher homologs of benzene should be readily accomplished. But the decomposition products resulting from the action of aluminium chloride upon benzene and its alkyl derivatives are much more complex than such as would result from the simple transposition of alkyl radicals, for polycyclic compounds have been isolated which could have been formed only by the rupture of the benzene ring with the formation of pentacyclic substances of the picene type.

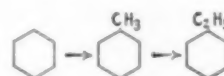
Anschütz and Immerdorff<sup>7</sup> gave in 1884 a note upon the course of reaction when toluene, (m) xylene and

ethylbenzene were treated with aluminium chloride as follows:

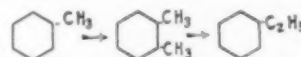


The mechanism of the reaction is explained by assuming a simple migration of the alkyl radical from one phenyl group to another. Friedel and Crafts<sup>8</sup> upon heating naphthalene and aluminium chloride from 100 deg. C. to 160 deg. C. found that benzene, hydronaphthalenes, and hydrogenated isodinaphthyl were formed in the reaction.

Upon testing further the effect of aluminium chloride on benzene<sup>9</sup> and toluene at a temperature between 180 deg. and 200 deg. C. they concluded that the reaction took place in the direction of:

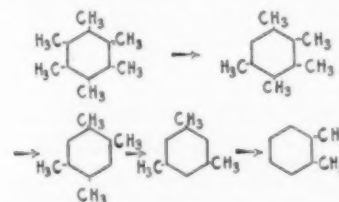


They noted that ethylbenzene resulted from toluene, which fact was not observed by Anschütz and Immerdorff.



In contradiction to Anschütz and Immerdorff, Friedel and Crafts stated that the reaction is much more complex than a simple migration of alkyl groups.

No theoretical discussion of the course of the reaction was attempted by either group of investigators. In treating hexamethylbenzene with aluminium chloride Friedel and Crafts<sup>10</sup> gave the reaction direction as:



They made the important observation that a gas was given off during the reaction of greater molecular weight than either methane or ethane and which was not absorbable in bromine, indicating paraffin formation. No exhaustive study has as yet been made as to the composition of the gases resulting from the action of aluminium chloride upon aromatic hydrocarbons.

At the boiling point temperature little action took place between the reagent and benzene, but upon increasing the temperature to 180 and 200 deg. C. in a sealed tube the principal resulting products were found to be toluene, ethylbenzene and diphenyl. Toluene

<sup>1</sup>Presented before the Organic Section at the Spring meeting of the American Chemical Society, Kansas City, Mo., 1917.

<sup>2</sup>Egloff and Twomey, Jour. Phys. Chem., 20, 121, 1916.

<sup>3</sup>Egloff, Twomey and Moore, Met. and Chem. Eng., 15, 387, 1916.

<sup>4</sup>Rittman and Egloff, Met. and Chem. Eng., 14, 70, 1915. Egloff and Moore, Jour. Ind. and Eng. Chem., 8 (1917).

<sup>5</sup>Berichte 11, 1627, 1878 and 12, 829, 1879.

<sup>6</sup>Berichte 14, 2624, 1881.

<sup>7</sup>Ibid. 17, 2816, 1884.

<sup>8</sup>Bull. Soc. Chim. 39, 195, 1883.

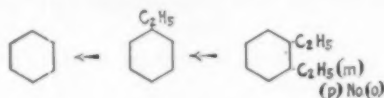
<sup>9</sup>Loc. Cit. 42, 196, 1885.

<sup>10</sup>Berichte 15, 1451, 1882. Journ. Chem. Soc. 41, 115, 1882. Compt. rend, 100, 692, 1885.





formed *no* ortho product of xylene. This seems to indicate that there may be some protective action of aluminium chloride in shielding the ortho position.



A residue was left in the flask which was a heavy black mass and was not investigated further.

Heating cymene with aluminium chloride gave a violent reaction and upon analysis of the reaction liquid gave mainly toluene. This would indicate that a splitting off of an isopropyl group resulted and not a migration over to another phenyl group, to form di or tri isopropyl derivatives of benzene. It seems likely that the reaction became exothermic and carried the reaction beyond the stability of the isopropyl compounds. Carrying out the reaction at a low temperature would yield entirely different results as to the migration theory of the Friedel and Crafts reaction.

Heise and Töhl<sup>17</sup> by passing hydrogen chloride through a solution of aluminium chloride and isopropylbenzene found that an isopropyl group would migrate to another phenyl radical. They found that the reaction products were propane, benzene, meta and para-diisopropylbenzene. It is significant that they report the specific paraffin hydrocarbon PROPANE to be a product of the reaction. The formation of PROPANE reported by Heise and Töhl has led the authors to review the data of Rittman, Byron and Egloff<sup>18</sup> upon the "Thermal Reactions of Aromatic Hydrocarbons in the Vapor Phase." The analytical results are given in distillation cuts and specific gravity of cymene, xylene and toluene fractions which have been subjected to varying temperature and pressure conditions. A scrutiny of the specific gravity of the benzene cut to 100 deg. C. shows a set of values ranging from 0.855 to 0.883 at 15.5 deg. C.

It is well known that the specific gravity of hydrocarbons is an additive property, and hence any value less than the specific gravity of pure benzene at 15.5 deg. of 0.883 must be due to a hydrocarbon or group of hydrocarbons with a specific gravity of less than 0.883 to bring it down to 0.855 at 15.5 deg. C. The lowering cannot be due to toluene, which has a specific gravity of 0.871 at 15.5 deg. C., hence in the *thermolization and pressurizing of aromatic hydrocarbons some paraffins or naphthenes must have been formed*. To what extent paraffins or naphthenes are formed requires further experimentation. In the present investigation of the action of aluminium chloride upon aromatic hydrocarbons the formation of hexahydro-toluene has been noted and will receive attention shortly.

Heise and Töhl treated ethyl, propyl<sup>19</sup> and butyl benzene with hydrogen chloride and aluminium chloride.

The products of the reaction for ethylbenzene were benzene, diethylbenzene (m) (p) and triethylbenzene. Propylbenzene gave as reaction products benzene, (m) (p) dipropylbenzene upon six hours' heating with hydrogen chloride and aluminium chloride.

Under similar treatment butylbenzene gave benzene, (m) (p) dibutylbenzene, (O), (m) and (p) xylene, pseudocumene and mesitylene. It is to be noted that

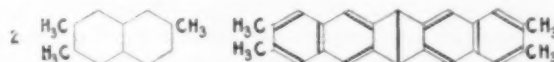
they report orthoxylylene which Ador and Riliet and also Anschütz failed to isolate in their reactions.

Homer<sup>20</sup> in 1907, upon heating naphthalene in the presence of aluminium chloride for a period of time ranging from thirty minutes to six hours, found a tar formation which upon analysis gave three distinctly new compounds with the empiric formulæ of  $C_{14}H_{10}$ ,  $C_{20}H_{12}$  and  $C_{26}H_{18}$ . She was unable to isolate the reaction products reported by Friedel and Crafts<sup>21</sup> of hydronaphthalene and hydronaphthyl. From a pale yellow oil, the fraction boiling between 215 deg. and 225 deg. C./10mm. gave a substance of the formula  $C_{14}H_{10}$ , which in all probability was either tetramethylnaphthalene or diethylnaphthalene. From a later absorption spectra<sup>22</sup> study of the compound it was found evidently to check up with 1, 4, 5, 8 tetramethylnaphthalene. From the fraction boiling above 300 deg. C./10mm. a red transparent resinous highly fluorescent solid was isolated having an empiric formula of  $C_{26}H_{18}$ . It was suggested that it might be a homolog of dinaphthanthracene  $C_{22}H_{14}$ , with a formula as shown by Russig.<sup>23</sup>



From absorption<sup>24</sup> values  $C_{26}H_{18}$  has a constitution similar to  $\beta\beta$  dinaphthyl, and therefore is probably tetranaphthyl. The empiric formula of  $C_{26}H_{18}$  exhibits an absorption curve similar to picene, and hence is very likely an alkyl derivative of picene.

The course of the reaction as Homer indicates it follows: naphthalene  $\rightarrow \beta\beta$  dinaphthyl  $\rightarrow$  tetramethyl or diethylnaphthalene  $\rightarrow C_{26}H_{18}$  homolog of dinaphthanthracene or alkyl derivative of picene  $C_{26}H_{18}$  tetranaphthyl. The probable equation would be:



Heating for "hours" a mixture of benzene, aluminium chloride and hydrogen chloride in a sealed tube Gustavson<sup>25</sup> recovered an oil with boiling point range to 360 deg. C. and a resinous mass. He isolated a compound with a boiling point of from 230 deg. to 232 deg. C. identical in properties with 3-phenyl-1-methyl cyclopentane, as given by Borsche and Menz.<sup>26</sup> Another compound was isolated with properties the same as those given by Kursanoff,<sup>27</sup> which analyzed diphenylcyclohexane. The toluene observed by Friedel and Crafts, according to Gustavson, was formed most likely by the passing of a methyl group upon methylcyclopentane by transposition to cyclohexane and then dehydrogenation of the methylcyclohexane. The compounds isolated by Gustavson from the reaction upon benzene were 3-phenyl-1-methylcyclopentane and diphenylcyclohexane.

Scholl, Seer and Weitzenbock<sup>28</sup> in 1910 isolated the compound perylen from the action of aluminium chloride on naphthalene by refluxing at 180 deg. C. for one

<sup>17</sup>Jour. Chem. Soc. 91, 1103, 1907.

<sup>18</sup>Comp. rend. 100, 692, 1885.

<sup>19</sup>Jour. Chem. Soc. 93, 1327, 1908.

<sup>20</sup>Jour. Prakt. Chem. 62, 30, 1900.

<sup>21</sup>Ibid.

<sup>22</sup>Compt. rend. 146, 640, 1908. Jour. Russ. Phys. Chem. Soc. 10, 390, 1878.

<sup>23</sup>Berichte 41, 190, 1910.

<sup>24</sup>Annalen 318, 309, 1901.

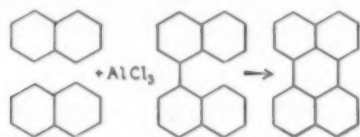
<sup>25</sup>Berichte 43, 2202, 1910.

<sup>17</sup>Annalen 270, 155; Berichte 24, 768.

<sup>18</sup>Journ. Ind. and Eng. Chem. 7, 1019, 1915.

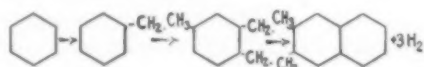
<sup>19</sup>Berichte 24, 768.

hour. The course of the reaction as assumed by them, naphthalene to dinaphthyl to perylen as follows:



Homer<sup>29</sup> refluxing benzene ten to fourteen days with aluminium chloride at 100 deg. C. isolated naphthalene as one of the products which had been overlooked by Friedel and Crafts,<sup>30</sup> if it formed at all, under the conditions of their experiment. She isolated similarly to Friedel and Crafts—toluene, xylene, ethylbenzene, diphenyl and phenol.

An assumed explanation of the formation of naphthalene from benzene is given:



Contrary to the findings of Friedel and Crafts, phenol was isolated only in the lower cuts. The following formula weights were determined for the distillation products, and further work is going on to determine their constitution.

Distillation Temperature	Molecular Weight
10 mm. pressure	
212 deg. C.	170
240	210
260	240
300	270

Summarizing the products reported by the various investigators upon the action of aluminium chloride and aromatic hydrocarbons, the following schematic outline is given which covers the actual compounds isolated under definite conditions of temperature and concentration. It must be recognized that the concentration of aluminium chloride, the time factor and temperature influence greatly the products resulting, and that no one reaction yielded all the products indicated, but that groups were isolated under definite conditions.

Benzene	<ul style="list-style-type: none"> <li>Toluene</li> <li>Ethylbenzene</li> <li>Diphenyl</li> <li>Diphenyl-cyclohexane</li> <li>3-phenyl-1-methylcyclopentane</li> <li>Naphthalene</li> <li>Phenols</li> </ul>
Toluene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Xylene (m) (p) no (o)</li> <li>Ethylbenzene</li> <li>Ditolyl (?)</li> <li>Dimethylantracene</li> <li>Phenols</li> </ul>
Xylene (m)	<ul style="list-style-type: none"> <li>Benzene</li> <li>Toluene</li> <li>Mesitylene</li> <li>Pseudocumene</li> <li>Durene</li> <li>Tetramethylantracene (?)</li> <li>Phenols</li> </ul>

Mesitylene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Toluene</li> <li>Xylene</li> <li>Pseudocumene</li> <li>Durene</li> <li>Isodurene</li> </ul>
Pseudocumene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Toluene</li> <li>Xylene (o) (m) no (p)</li> <li>Mesitylene</li> <li>Durene</li> <li>Isodurene</li> <li>Pentamethylbenzene</li> </ul>
Pentamethylbenzene	<ul style="list-style-type: none"> <li>Durene</li> <li>Isodurene</li> <li>Hexamethylbenzene</li> </ul>
Hexamethylbenzene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Toluene</li> <li>Xylene</li> <li>Mesitylene</li> <li>Pseudocumene</li> <li>Durene</li> <li>Isodurene</li> <li>Pentamethylbenzene</li> </ul>
Ethylbenzene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Diethylbenzene (p) (m) no (o)</li> <li>Triethylbenzene</li> </ul>
Propylbenzene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Dipropylbenzene</li> </ul>
Isopropylbenzene	<ul style="list-style-type: none"> <li>Propane</li> <li>Benzene</li> <li>Diisopropylbenzene</li> </ul>
Butylbenzene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Dibutylbenzene (m) (p)</li> <li>Xylene (o) (m) (p)</li> <li>Mesitylene</li> <li>Pseudocumene</li> </ul>
Cymene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Toluene</li> </ul>
Naphthalene	<ul style="list-style-type: none"> <li>Benzene</li> <li>Hydonaphthalenes</li> <li>Hydrogenated isodinaphthyl</li> <li>Perylen</li> <li>Alkyl derivatives of Picene (C<sub>24</sub>H<sub>18</sub>)</li> <li>Tetranaphthyl (C<sub>20</sub>H<sub>14</sub>) (?)</li> <li>1,4,5,8 tetramethylnaphthalene</li> <li>C<sub>18</sub>H<sub>12</sub></li> </ul>

### Experimental

The experimental method consisted of distilling 500 c.c. of the aromatic hydrocarbon to which was added 10 per cent by weight of anhydrous aluminium chloride in a 1000-c.c. flask attached to a Glinzky column and 24-in. Liebig condenser. The temperature of distillation was maintained over a period of twenty-four hours below the boiling point temperature of the aromatic treated. An evolution was noted of hydrogen chloride in each case of distillation. The distillate was neutralized with a 10 per cent sodium hydroxide solution, washed and dried over calcium chloride. The residue in the flask was filtered free of aluminium chloride, aluminium chloride compounds of the aromatic hydrocarbon used.

<sup>29</sup>Proc. Camb. Phil. Soc. 16, 65, 1911.

<sup>30</sup>Loc. cit.



and carbon. The filtered oil was neutralized, washed and dried over calcium chloride, and added to the first distillate. The hydrocarbon liquid was then distilled in a Glinsky column and analyzed for its benzene and toluene content."

The benzene was identified as the dinitrocompound and the toluene as the trinitrotoluene. The phenol present was identified by its boiling point and melting point. No attempt was made to isolate the cresols and higher phenolic compounds. The hexahydrotoluene was isolated by taking 100 c.c. of the fraction from benzene and toluene and by repeated extraction with fuming sulphuric and centrifuging after each treatment, and treating the residue liquid.

As many as twenty extractions with fuming sulphuric and five with fuming nitric acid were necessary to finally obtaining a liquid which resisted the action of both fuming sulphuric and nitric acid at room temperature. This unattacked liquid was then neutralized with sodium hydroxide, washed and dried over fused calcium chloride. The specific gravity, refractive index, boiling point and molecular weight by means of the vapor density method were taken of the residue liquid and clearly indicated hexahydrotoluene.

#### MATERIALS USED

**Benzene.**—The benzene used was water-white, thiofen-free and gave a specific gravity of 0.883 at 15.5 deg. C. and colorless upon sulphuric acid treatment. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	79.5
99.5	80.5
Dry point	80.9

**Toluene.**—The toluene was water-white, clear color in the sulphuric acid layer. The specific gravity at 15.5 deg. C. 0.871. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	109.0
99.0	110.5
Dry point	110.8

**Xylenes.**—The xylenes were water-white in color and gave a very faint lemon color in the sulphuric acid layer. This was cleared up to an almost imperceptible tint upon repeated acid treatment. The specific gravity of the mixture at 15.5 deg. C. was 0.870. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	137.0
98.0	137 to 142
Dry point	143.2

**Cumene.**—The cumene used was water-white and slight lemon color on sulphuric acid treatment. The specific gravity of the sample at 15.5 deg. C. was 0.867. The distillation analysis:

Per Cent by Volume	Temperature Deg. C.
1st drop	151.0
94.0	155.0
99.3	160.0
Dry point	161.4

**Cymene.**—The specific gravity of the cymene used in this experiment at 15.5 deg. C. gave a value of 0.865. The distillation analysis:

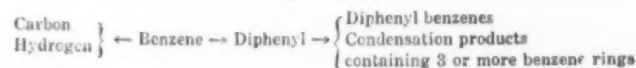
Per Cent by Volume	Temperature Deg. C.
1st drop	173.0
98.0	175.2
Dry point	178.6

#### Experimental Data

##### A. BENZENE

The benzene after distillation over a period of twenty-four hours in the presence of 10 per cent by weight of aluminium chloride gave after neutralizing, washing and drying a percentage yield of 92 per cent of unchanged benzene, approximately 1 per cent of phenols and 6.8 per cent of tar. This is in accord with the findings of Friedel and Crafts, who found but little change in the benzene at its boiling point; but when they raised the temperature to 180 deg. and 200 deg. C. in a sealed tube considerable decomposition took place with toluene, ethylbenzene and diphenyl formation. Gustavson isolated 3-phenyl-1-methylcyclopentane and diphenylcyclohexane from the action of aluminium chloride upon benzene. Homer upon refluxing benzene from ten to fourteen days at 100 deg. C. found naphthalene resulting from the reaction.

The formation of naphthalene from benzene by the action of aluminium chloride is highly interesting. Zanetti and Egloff," working with catalysts and varying temperatures in the gas phase upon benzene, were unable to isolate naphthalene, although every precaution was taken to find it in the reaction. They found the reaction took the following course:



The action of aluminium chloride under the conditions of Friedel and Crafts, Gustavson and Homer's experiments upon benzene seem to be much more vigorous than temperature changes of Zanetti and Egloff's work. The benzene ring is disrupted entirely in forming naphthalene in the presence of aluminium chloride. The substances isolated from the action of aluminium chloride on benzene is tabulated as follows:

Benzene	Toluene
	Ethylbenzene
	Diphenyl
	Diphenylcyclohexane
	3-phenyl-1-methylcyclopentane
	Naphthalene
	Phenols

##### B. TOLUENE

There resulted from the action of aluminium chloride upon toluene a yield of 15.0 per cent benzene and 3.5 per cent xylenes. Sixty per cent of the original toluene was recovered, and there were formed 1 per cent of phenols and 0.8 per cent of hexahydrotoluene.

The hexahydrotoluene was isolated by repeated treatment with fuming sulphuric and nitric acid upon the benzene fraction. After each treatment the mixture was centrifuged and the residue sulphonated. Toward the end of the sulphonation fuming nitric acid was used. The unsulphonated and unnitrated residue was then neutralized, washed and dried over fused calcium chloride.

The toluene used in the experiment was subjected to

<sup>11</sup>Rittman, Twomey and Egloff, Met. and Chem. Eng., 13, 682, 1915.

<sup>12</sup>Jour. Ind. Eng. Chem. 9, 350, 1917.

similar conditions in order to isolate any hexahydro-toluene which may have been present. The toluene source was a coal-tar oil and resulted from the thermal decomposition of coal, and it was thought that perhaps the hexahydro-toluene isolated from the reaction of aluminium chloride upon the toluene might have been present in the starting material. But not a trace of an unsulphonated or unnitratable residue was obtained. It is quite certain that the toluene used contained no hexahydro-toluene. The refractive index, specific gravity, boiling point and molecular weight of the residue, unsulphonated and unnitrated were taken.

The refractive index was taken by means of a Pulfrich refractometer; the specific gravity by means of a l.c.c. pycnometer; the boiling point by means of the Smith and Menzies<sup>2</sup> method for minute quantities of material and the molecular weight by the Victor Meyer vapor density method. The following table tabulates the data:

	Values for the Physical Constants Found Hexahydro-toluene	Values for the Physical Constants According to Beilstein
Refractive index.....	1.42775	1.41795 1.42430
Specific gravity.....	0.7648/15.5 deg. C.	0.778/0 deg. C. 0.7662/18.5 deg. C. 0.7641/20.0 deg. C.
Boiling point.....	97.2 deg. C.	98.0 deg. to 100 deg. C. 97.2 deg. to 98 deg. C.
Molecular weight		98
Vapor density method..	103	

Gustavson argued that Friedel and Crafts' toluene from benzene formed via a methyl radical migrating from methylcyclopentane to hexahydrobenzene forming hexahydro-toluene and then by dehydrogenation to toluene. The evidence from the present paper indicates clearly the formation of hexahydro-toluene, a step which was pure speculation on the part of Gustavson. His explanation of toluene formation from benzene seems to have experimental verification, due to the actual isolation of hexahydro-toluene in the benzene fraction from the action of aluminium chloride upon toluene.

To the list of compounds isolated from the reaction products of aluminium chloride upon toluene, hexahydro-toluene must now be added:

Toluene	Benzene
	Hexahydro-toluene
	Xylene (m) (p) no (o)
	Ethylbenzene
	Ditolyl?
	Dimethylantracene
	Phenols

#### C. XYLENE

Xylene is an excellent source of benzene and toluene by the action of aluminium chloride. The xylene upon treatment gave 19.0 per cent of toluene and 5.6 per cent of benzene, with a recovery of 30.0 per cent of starting material. Phenols and cresols were formed in appreciable amounts during the reaction. Hexahydro-toluene was isolated from the toluene fraction and gave the following constants, refractive index 1.41637, specific gravity of 0.7640 and a boiling point of 98.0 deg. C. and M. W. of 103. The starting material was subjected to the same treatment in regard to isolating the hexahydro-toluene but no trace was found in the original xylene.

The following list covers the compounds isolated from the action of aluminium chloride upon xylene:

(m) Xylene	Benzene
	Toluene
	Hexahydro-toluene
	Mesitylene
	Pseudocumene
	Durene
	Tetramethylantracene?
	Phenols

#### D. CUMENE

Under the conditions of the experiment cumene formed 1.5 per cent of benzene; 2.7 of toluene and 26.5 per cent of xylene with 63.6 per cent of recovery for the starting material.

It would appear that there is a gradual splitting off of alkyl radicals, to the next lower homolog of benzene. Cumene does not appear to form benzene and toluene in yields sufficient to make it an important source for these two substances.

#### E. CYMENE

Cymene upon aluminium chloride treatment gave an excellent yield of toluene. The per cent of toluene upon the basis of cymene used was 14.3, with 0.8 per cent benzene and 7 per cent xylene formation.

The percentage of recovered material was 28.5 with 48.4 going to a jelly-like mass. Work upon this jelly-like mass is proceeding and will be reported upon in a future communication.

#### Tabulation of the Data

The data are expressed in percents of aromatic hydrocarbons upon the basis of aromatic hydrocarbon used in the reaction.

Per cent recovered of	HYDROCARBON USED IN THE REACTION				
	Benzene	Toluene	Xylene	Cumene	Cymene
Benzene .....	92.0	15.0	5.6	1.5	0.8
Toluene .....	60.0	19.0	2.7	14.3	
Xylene .....	3.5	30.0	26.5	7.0	
Cumene .....	...	...	63.6		
Cymene .....	...	...	...	28.5	
Residue .....	6.8	20.0	43.0	4.4	48.4

#### Summary

1. A review of the literature dealing with the aluminium chloride reaction on aromatic hydrocarbons has been given together with conclusions as to the tendencies of the individual compounds under treatment.

2. A chart has been given of the specific compounds isolated from individual aromatics upon aluminium chloride treatment.

3. A naphthene overlooked by previous experimenters has been isolated from the reaction of aluminium chloride upon toluene and xylene and identified as hexahydro-toluene.

4. Quantitative recoveries, lacking in the literature for the hydrocarbons, benzene and toluene from the aluminium chloride reaction upon aromatics were determined as follows:

Benzene—slight change.

Toluene—15 per cent benzene, 3.5 per cent xylenes . . . .

Xylenes—5.6 per cent benzene, 19 per cent toluene . . . .

Cumene—1.5 per cent benzene, 2.7 per cent toluene, 26.5 per cent xylenes . . . .

Cymene—0.8 per cent benzene, 14.3 per cent toluene, 7 per cent xylenes . . . .

<sup>2</sup>Smith and Menzies, J. A. C. S. 32, 897, 1910.

## The Influence of High Temperature Upon the Elastic and Tensile Properties of Wrought Iron

By Frank A. Epps and E. Olney Jones

Owing to the comparatively recent use of iron and steel in a stressed condition at temperatures considerably above the usual range, it was thought by the authors that an investigation in this field might prove of commercial and engineering value. An examination of the engineering texts and literature showed that little had been done along this line, and the values that had been obtained were only for ultimate tensile strength, percentage elongation and percentage reduction of area. At the outset, therefore, it was decided to obtain reliable data on the variation of the elastic limit, and to check, if possible, the results obtained, by our predecessors, on the other properties.

The commercial application of the test is well worth considering. It is now generally admitted that all design work should be based on the elastic property of the metal, rather than on its ultimate strength. For metals at ordinary temperature, the use of a proper factor of safety brings the stress for which the piece is designed well within the elastic limit. As the results following will show, at higher temperatures this design factor of safety will have to be modified greatly, or the work will have to be designed wholly on an elastic limit basis. Up to the present, it is believed that this has been taken care of by greatly increasing the factor of safety when temperature conditions are to be considerably above normal. If the factor of safety has not been increased on the basis of experimental data, it is possible that there are instances now in existence where the metal is under a stress exceeding its elastic powers.

A few specific applications of the subject are given herewith:

Temperatures of superheated steam vary from 450 to 550 deg. Fahr. The strength of tubes, valve stems, etc., as affected by these temperatures, is indeed worthy of serious consideration.

Average boiler temperatures range from 300 to 450 deg. Fahr., and even within this range it is possible that the elastic properties of the metal are changed.

Metal rigging above large crucibles or ladles carrying molten iron is exposed to a heat far more intense than would be supposed. The failure of any part of such a system might result in a great loss to property and life.

Gas engine and gas turbine design is largely complicated by the temperature to which the metals may be safely subjected.

Blacksmiths have learned from the school of experience that iron should not be worked below a red heat. While it is not the purpose of this investigation to reach the temperature of a workable red heat (1500 deg. Fahr.), it will be shown that at least it is very inadvisable to work iron below temperatures of 1000 deg. Fahr.

In outline, the four main features to be considered are:

1. The metal to be tested.
2. The method of heating the specimens.
3. The method of measuring temperature.
4. The method of measuring elongation, particularly with the elastic limit.

It was decided to test a grade of wrought iron made directly from pig. All of the specimens were secured from the same lot, and further uniformity was assured from the fact that the grade was a special one and the iron unusually pure. The specimens were made 1 in. x  $\frac{1}{4}$  in. flats milled down for a length of 5 in. to  $\frac{1}{2}$  in. x  $\frac{1}{4}$  in. Flats were chosen because of the ease with which the specimens could be prepared, and because time was an important factor. The overall length of the specimen was determined from the size of the furnace and the necessary additional room required between the heads of the testing machine for the attachment of the extensometer.

An electric furnace was used for heating the specimens. Gas and gasoline heaters were considered, but it was thought that the gases of combustion might have an effect of changing the chemical properties of the iron, particularly in its heated state. The electric furnace was therefore chosen, not only because it eliminated this possibility, but because its construction, operation and control were simple.

In deciding upon the method of measuring temperature, the main considerations were durability, accuracy, simplicity and cost. A copper wire resistance pyrometer was first considered, but the suggestion was abandoned, because of the excessive oxidization of copper when exposed to heat. Platinum resistance was next proposed, but it was discarded in favor of base metal thermocouples which had all of the desired qualifications.

Provision for a satisfactory extensometer was the greatest difficulty encountered in the entire investigation. Strength, rigidity, lightness and accuracy in minute measurement were all essential features. It was necessary to read outside of the furnace, an elongation in five inches of not more than .005 in. A cathetometer was suggested, but the only one available had a least count of .001 in., which was clearly too large for accurate work. A cast-iron rigging was made so that a Berry Strain Gauge might be attached outside of the furnace. This failed to work on account of excessive friction in a sliding arm, and to generally unbalanced forces throughout the mechanism. Finally an instrument was devised that worked well and filled all the requirements. It will be explained later.

The furnace consisted of an inner cylinder of sheet iron 2 in. in diameter and 11 in. long. Around this cylinder is wrapped a layer of asbestos .1 in. thick, on which is wound 18 ft. of nickel-chrome ribbon, the total resistance being about eleven ohms. A sleeve of a special heat-resisting compound surrounds the inner cylinder. A half-inch wrapping of corrugated asbestos sheeting; ends of asbestos board, held together by four rods, and the necessary binding posts, etc., completed the furnace.

The thermocouples were made of iron and constantan wire, twisted together and welded on the ends. The wires were insulated with asbestos. Six of these were made. A Leeds and Northrup Potentiometer, used in connection with a standard cell, storage battery and auxiliary resistances, was used to measure the e.m.f. generated by the thermocouples. The cold end was kept at room temperature and the necessary correction was made. The potentiometer was used in preference to a millivoltmeter on account of the superior accuracy of the former for this class of work.



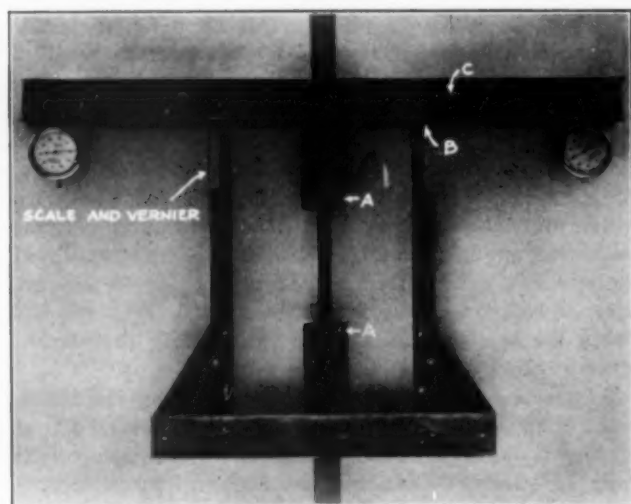


FIG. 1—EXTENSOMETER

The extensometer is shown in Fig. 1. The specimen is gripped by knife edges at A-A and the entire extensometer is supported at these two points. The uprights are free to move through the upper beam. A lever, supported by trunnion bearings at C, rests with one end on shelf B and the other on the movable shaft of a B. L. Ames Dial Gauge. A rubber band keeps this lever bearing continually on shelf B. The lever has a five-to-one ratio, the dial has one hundred divisions marked on it, one division being equivalent to the movement of the dial shaft or stem through .001 in. Consequently the least count of the instrument is  $1/5 +$

$1/1000 = .0002$  in. Readings of both dials were taken simultaneously and the average of these two readings was taken as the elongation. The grip pieces were made of cast iron; the remainder of the structure was made of No. 26 gage sheet iron, bent into channel forms, to insure rigidity, and riveted together.

#### CALIBRATION OF THE APPARATUS

Considerable time was spent trying to calibrate the furnace for temperature current relations, and for temperature variation in the inner shell. After such curves had been obtained, the furnace burned out, and it was necessary to rewind it. An attempt was made to secure similar curves for the second oven. The relation of current to temperature is only approximate. There was considerable of what might be called temperature lag; that is, if the oven was brought up to a certain temperature and held at that point, it would require a greater current than if the oven had been previously heated and the current so decreased as to allow the temperature to fall to the same point. Again the temperature lag in certain sections of the oven was different; that is, if the temperature was raised to a certain value, the temperature range in the oven would be quite different than if the temperature were allowed to decrease to the same value. The maximum variation of temperature was never greater than about ten per cent.

Owing to the fact that the temperature had different values in different parts of the furnace, readings of temperature were taken at three points, viz., top, middle and bottom. These were averaged by assuming the

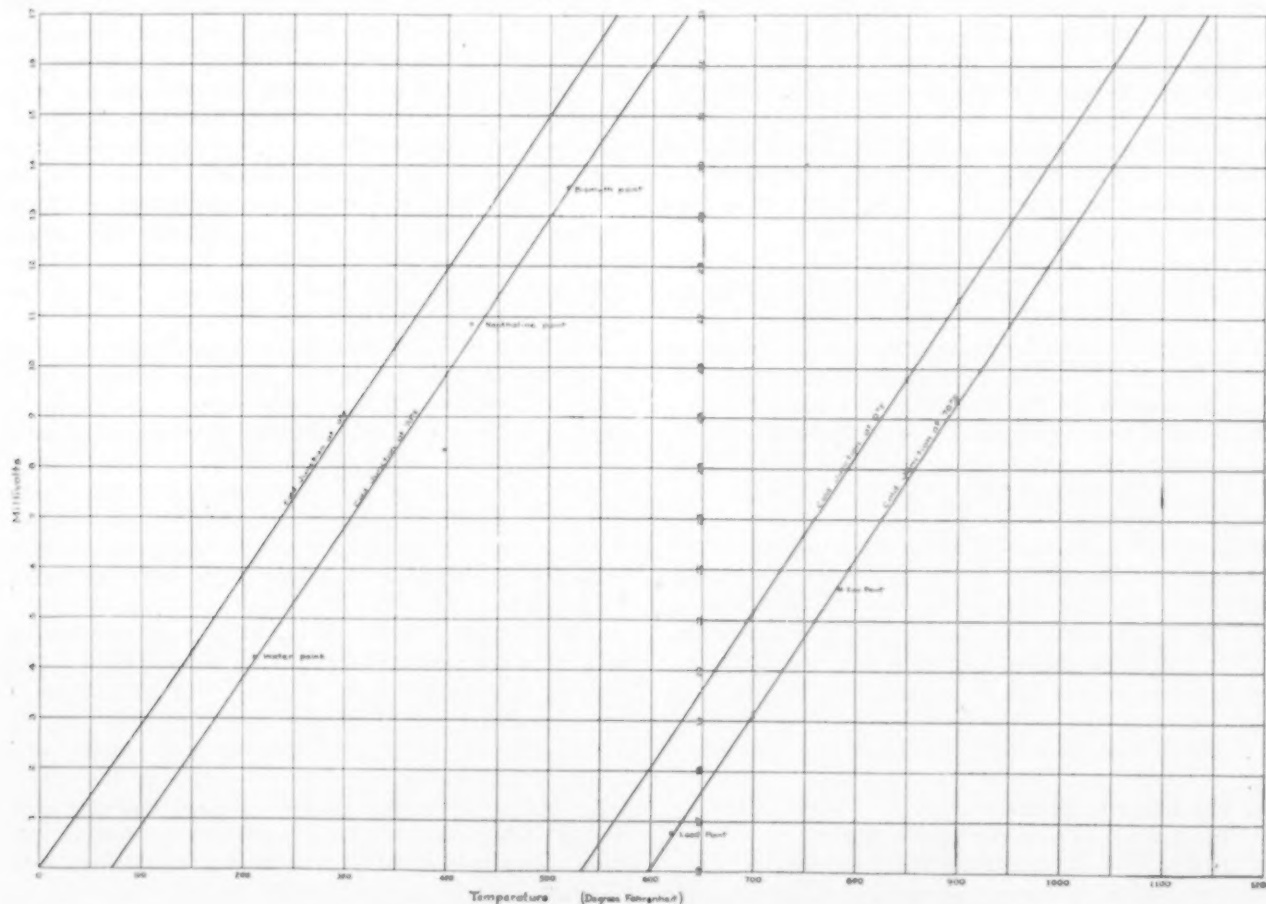


FIG. 2—CALIBRATION CURVE OF IRON-CONSTANTAN THERMOCOUPLE

change to occur along a second degree curve. This average temperature was taken as the temperature at which the elastic limit, modulus of elasticity, and percentage elongation occurred. Since the point in the oven at which the break occurred was readily ascertained, and since the temperature could be obtained at that point by means of a second-degree curve connecting the temperatures of the top, middle and bottom, that particular temperature was considered as the one at which the ultimate strength and percentage reduction of area were valid.

A calibration curve of an iron-constantan thermocouple shown in Fig. 2 was obtained from the Leeds & Northrup Company of Philadelphia. One of the "home-made" thermocouples was compared with this curve at the boiling points of water and naphthaline, and at the melting points of lead, bismuth and zinc. This couple compared very closely with the one for which the curve was drawn, and so it was assumed that for the case at hand the Leeds & Northrup curve was sufficiently accurate.

The other thermocouples, five in number, were tied with the calibrated one so that the junctions of all were as nearly as possible at the same point. They were then inserted in the furnace which was brought up to a fairly high temperature, and the e.m.f.'s generated by each were read almost simultaneously. Each registered the same e.m.f. in recording the same temperature, and so, in connection with the fact that all couples were made from the same pieces of wire, it was considered that this was ample proof that all were alike and answered to the one calibration.

The curve in Fig. 2 shows the Leeds & Northrup curve with the cold junction at zero degree Fahrenheit. A curve is also drawn for the cold end at 70 deg. Fahr. This was obtained by deducting the millivolts corresponding to 70 deg. Fahr., from the millivolts on the zero curve. The various actual points obtained by the calibration are corrected for the difference between room temperature and 70 deg. Fahr., and plotted over the 70 deg. curve. A maximum discrepancy of about

7 deg. Fahr. is observed at the boiling point of naphthaline. The naphthaline used was commercial "camphor," hence impurities present probably altered the boiling point slightly.

The extensometer was checked for accuracy by moving one end of the multiplying lever through a known distance by means of a micrometer screw, and reading the amount of motion on the dial. The error was less than one per cent. Both levers were checked in this manner.

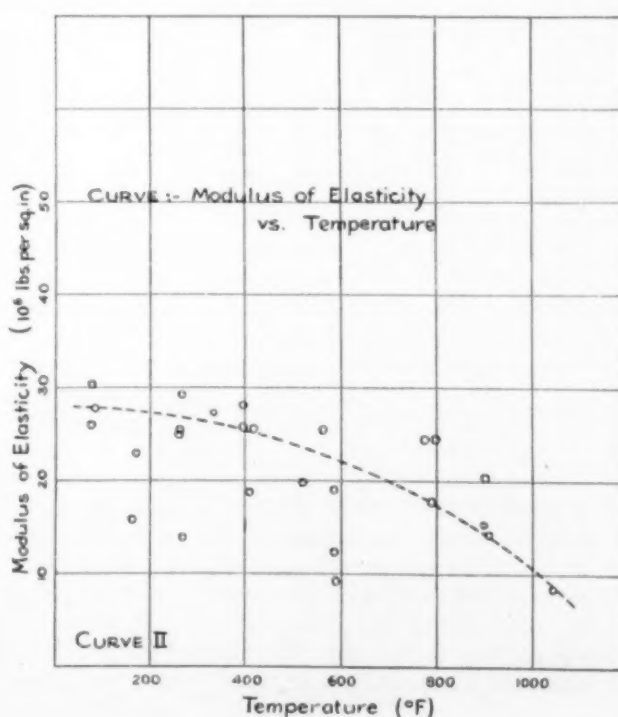
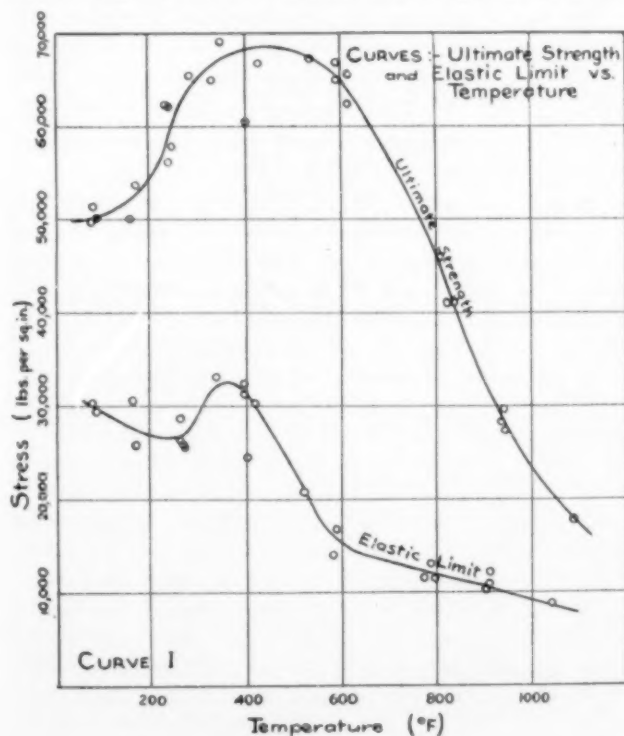
The testing machine was made by Tinius Olsen & Co. It was checked for accuracy by loading the table with known weights and measuring the same on the weighing beam, which had previously been balanced to zero. The error was so slight as to be negligible.

#### PREPARATION FOR AND CONDUCT OF TEST

Before actually conducting a test there were many preliminaries that had to be repeated for each. The first step was to determine accurately the dimensions of the specimen. The knife-edge extensometer grips were then placed on the specimen 5 in. apart, and made tight by means of bolts. By using knife edges instead of set screws and punch holes, the surface of the specimen was not damaged. In such a small specimen it is probable that a deep punch mark would so reduce the area of cross section as to weaken the specimen considerably at that point and cause the rupture to occur at the grips.

In attaching the thermocouples great care was taken to see that the welded tips were in contact with the specimen, so as to register more nearly the specimen temperature than the oven temperature. Three thermocouples were used in each test, one just below the top knife edge, one in the middle and one just above the bottom knife edge. From the readings of the three, the temperatures throughout the furnace could be closely approximated. These thermocouples were tied securely to the specimen by means of asbestos string.

The specimen and thermocouples were placed prop-



erly inside the furnace, the open ends of which were carefully packed with asbestos to prevent heat leakage. The extensometer was fastened to the projecting lugs of the knife edge grips, and the whole assemblage was finally put in the testing machine. Great care was taken at this point to get the specimen exactly in the middle of the top and bottom grips, so that the pull would be directly along the axis of the specimen.

The balance beam was adjusted to a correct zero reading and the specimen was stressed two hundred pounds for an initial reading.

Each test lasted, roughly, from twenty to thirty minutes. The machine was run at the lowest speed possible, about 1-in. movement of the drawhead per hour. The weighing beam was kept in constant balance, and for every one hundred and twenty-five increment in tension, the dials were read simultaneously. After passing the yield point, the dials would soon reach their limits, and a scale and vernier attached were used for measuring the further elongation to the point of rupture.

#### SUMMARY AND DISCUSSION OF RESULTS

A complete summary of all tests is given in the accompanying curves.

From these results it appears that the ultimate tensile strength of wrought-iron bars increases as the temperature increases from 70 deg. Fahr., until a maximum is reached between 350 deg. and 550 deg. Fahr.

From the temperature of maximum strength, the tenacity diminishes rapidly until the highest temperatures covered by these tests are reached.

The greatest gain over the strength of the metal at 70 deg. Fahr. was 37.6 per cent. This occurred at 430 deg. Fahr., as judged from curve I, page 69. The loss at 1000 deg. Fahr., over the strength of the metal at 70 deg. Fahr., was 53.5 per cent. A continuation of the curve at 1200 deg. Fahr. indicates a loss in strength of 75 per cent.

The elastic limit appears to decrease from 70 deg. Fahr. to about 270 deg. Fahr., showing a maximum decrease of about 13 per cent. From that temperature the elastic limit appears to suddenly increase to about 350 deg. Fahr., where it reaches its maximum value of

about 10 per cent above the stress at 70 deg. Fahr. From here on it gradually drops and at 1000 deg. Fahr. shows a loss of 70 per cent over the elastic limit at 70 deg. Fahr.

Owing to a period of rapid yielding without increase of stress, the yield point is well defined at moderate temperatures. This yield point, however, vanishes at about 500 deg. Fahr., and the stress-deformation curve assumes a gradual slope from the start to finish.

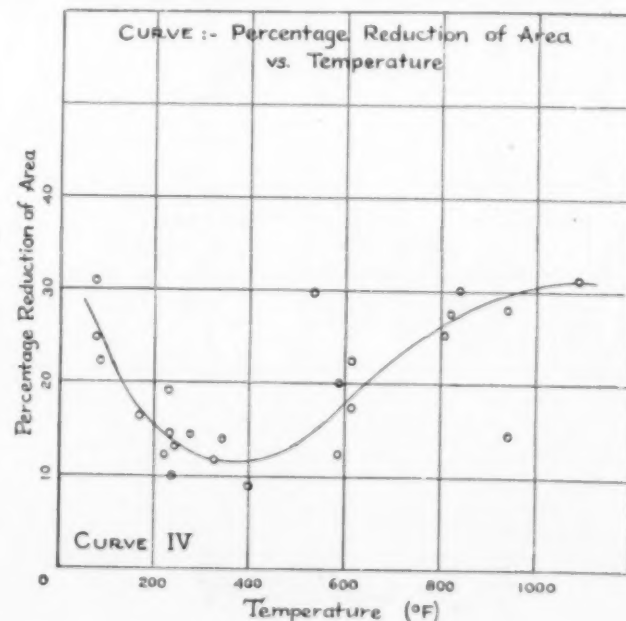
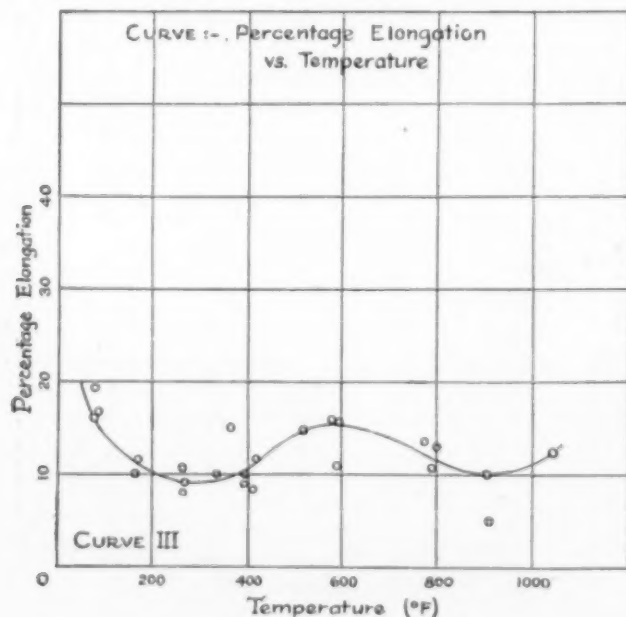
With reference to elongation under stress, this peculiarity is noticed: That greater rigidity exists under certain stresses at intermediate temperatures than at either higher or lower temperatures. Thus it will be noticed in Curve III that at 300 deg. Fahr. and 900 deg. Fahr. the metal shows only about half the elongation that it shows at 70 deg. Fahr. It is surmised that beyond 1000 deg. Fahr. the curve gradually rises and the metal exhibits powers of greater ductility as it approaches a workable heat.

Other remarkable features in the elongations are found in bars tested at temperatures varying from 200 deg. to 400 deg. Fahr., in which there are displayed alternate periods of rigidity and relaxation under increasing stresses, resembling and yielding described as occurring with bars immediately after passing the elastic limit.

It will be readily observed how irregular Curve II is beyond the yield point. Some of the tests taken at this temperature showed even greater irregularity. The repetition of these intervals of rigidity and relaxation is suggestive of some remarkable change taking place within the metal in this zone of temperature, conspicuous in a series of tests possessing many remarkable features.

The contraction of area at the place of rupture varies with the temperature of the bar. It appears that the contraction of area of wrought-iron bars is a great deal less between 200 deg. and 600 deg. Fahr. than at 70 deg. Fahr., and within this range of temperature there is a tendency to fracture obliquely across the bar.

The results obtained for the modulus of elasticity have very little value, except that they indicate a gradual decrease. The length over which the stretch was measured (five inches) was too small to obtain an accurate





value of elongation within the elastic limit. The points obtained by the extensometer up to an elongation of .0008 inches were seldom of value, since it took nearly that long to get the test "under way." In drawing the average straight line through a series of points up to the elastic limit, the least difference in slope would make an appreciable difference in the elongation as measured by the abscissae. In some cases the least count in this elongation amounted to 5 per cent of the total, and in computing the modulus a variation of 5 per cent would mean a variation of perhaps a few millions. Consequently no curve was traced through the points, but instead a dotted curve was drawn showing the variation that might be expected according to the results obtained by other investigators (Curve II).

In all cases the temperatures recorded were those at the surface of the specimen. The accuracy of this method might be questioned, e.g., whether or not the recorded temperature was the actual temperature of the iron. This was investigated by drilling a hole in a specimen, inserting a thermocouple so that the welded tip was in the central part, and then carefully plugging up the hole so that no heat could get in by air conduction. It was demonstrated by taking the inner temperatures and the outer surface temperatures simultaneously that a maximum difference of thirty degrees might be expected at the highest temperatures. At low temperatures the difference was almost negligible. Consequently the authors felt justified in using the surface temperatures throughout, since the maximum error would only be a few per cent and the curves would not be changed appreciably.

It is shown conclusively that should similar iron be used in work where the design factor of safety was five, and where the temperatures were 900 deg. Fahr. or above, the part under consideration would be stressed beyond its elastic limit if the allowable stress was applied. Furthermore, at that temperature the factor of safety on the ultimate strength would be reduced to three. Curve I shows the relation of ultimate strength to elastic limit throughout the complete temperature range.

For tubes, valves, pipe lines, etc., carrying superheated steam, Curve I shows that at 600 deg. Fahr. the elastic limit has fallen 50 per cent of its value at ordinary temperature, hence a design factor of safety in superheater construction should be so modified as to give an ample factor on the elastic limit at this temperature. Assuming that the factor of safety is five on the ultimate strength at 70 deg. Fahr., this would be equivalent to a factor of three on the elastic limit at the same temperature. Therefore, considering that the metal should never be stressed to more than one-third of its elastic power, at 600 deg. Fahr., the factor of safety would have to be ten on the ultimate strength of the metal at 70 deg. Fahr.

Boiler temperatures do not come so high that it would be necessary to change the factor of safety in their design.

With reference to the metal rigging above large crucibles and ladles as previously mentioned, it is not known just what temperatures are reached, but they are probably as high at 600 deg. or 800 deg. Fahr., in which case it is clear that some allowance must be made for the temperature service alone.

Reference to Curve III indicates that the metal is very brittle between 150 deg. Fahr. and about 1100 deg. Fahr. Where this state exists it is, of course, impractical to work the metal. In other words, it would be better to work the metal cold than at 200 deg. Fahr., at which temperature it might fracture without warning. Nine hundred degrees Fahrenheit is even a more critical point, for here the ultimate strength and the elastic limit have dropped to less than half their original values.

The conclusions attained are rather startling. The wide fluctuations in the physical properties are not generally realized, and it seems that the field for further research is a wide one. An exhaustive series of experiments along the general lines of this investigation, on different grades of iron, steel, brasses, etc., and the publication thereof, ought to benefit the world of commercial design to a great extent. A microscopical analysis of the structure of the metals after having been broken at different temperatures, would very likely show interesting results, judging from the superficial examination of the breaks in this experiment. Tests conducted while the iron was in its recalcrescent stage would prove likewise an exceedingly interesting field for investigation.

#### REFERENCES

(1) "The Change of the Modulus of Elasticity and of the Other Properties of Metals with Temperature," by Prof. F. C. Lea and O. H. Crowther, published in *Engineering* Oct. 16, 1914.

(2) "Strength of Mild Steel at High Temperatures," published in *Engineering* March 30, 1906.

(3) "Versuche über die Festigkeitseigenschaften von Flusseisenblöcken bei gewöhnlicher und höher Temperatur," by Prof. C. Bach of Stuttgart, published in *Die Zeitschrift des Vereines Deutscher Ingenieure*, August and September issued in 1904.

(4) "Experiments at the Watertown Arsenal," by the United States Government, published in the Proceedings of the American Society of Naval Engineers, 1888.

Reference No. 1 deals with several metals including mild steel. The authors apparently have very good results for the modulus of elasticity, and they obtained values for ultimate strength and reduction of area very similar to those obtained in this investigation. It is possible, perhaps, that with the grade of metal used a definite yield point was obtained at as high a temperature as 550 deg. C. However, for most wrought iron and mild steel, it is impossible to obtain a definite yield point as indicated by the drop of the beam, after 500 deg. Fahr. or 260 deg. C. has been reached. This statement is confirmed by the experiments at the Watertown Arsenal in 1888, and by the investigations of Prof. C. Bach in 1904.

Reference No. 2 is merely a digest and translation of No. 3 by Prof. C. Bach, who reports very similar behavior to that observed in this investigation.

Reference No. 4 is the most complete treatise on record, and while the investigations herein disagree on minor points, still in main the phenomena observed are identical. This reference is the only one that contains any information concerning the elastic limit of the metal. Several grades of iron and steel were investigated, and it is noteworthy that they all showed similar characteristics.

## Rubber Soles

By Andrew H. King

For quite a number of years we have been familiar with the type of rubber soled shoe known in the trade as "tennis." These slippers are made in many grades and styles. The most general characteristic has been cheapness. In fact, many of them are so cheap as to be next to worthless. Do not misunderstand me—there are good makes of tennis shoes, but to get them one must pay money. Because of this general cheapness both in price and in quality the public has come to look on a rubber-soled shoe as not exactly high class. That this is a mistake is now being forced home by extensive educational advertising.

Within the past two years the price of leather has advanced something like 120 per cent, and in fact genuine oak tanned leather is to-day extremely hard to get at any figure. People must have shoes, and since leather is beyond their reach a substitute must be found. Many times in the past the substitute has proved far superior to the original article. This case has been no exception, for with comparatively little effort rubber manufacturers have been able to turn out soles in every way equal, and in many ways superior, to any leather sole ever made.

The next step is education. Shoe manufacturers have had to learn the difference between rubber and leather. These differences while not great are nevertheless important, and the ways of building shoes have had to be altered a little to suit the new conditions. Shoemakers have done this because they were convinced of the virtue of rubber soles. The general public has been a bit skeptical, mainly because of the subconscious memory of the old tennis shoe. The best argument, perhaps, is in the appearance of high-priced \$8, \$10, and \$12 rubber soled shoes bearing the name of reputable manufacturers. Last year rubber soles were a fad. To-day they are a necessity.

There is quite a little psychology in it. For a thing to be appreciated by the people at large there must be a perfect whirlwind of enthusiasm, a craze, a sort of mono-mania. In time this subsides and the great outstanding utilitarian virtues of the thing are generally accepted. It is not long ago that bicycles were the fad. Then the bubble burst, people's attention was directed elsewhere. Sales fell off and prices with them. But the bicycle was not done for. It has a place in the world because it is of use. To-day we have the three-speed bicycle and the motor wheel attachment. It is here to stay.

Tango dancers long ago discovered the usefulness of the rubber sole. In fact, the modern dances almost without exception, would be impossible without them. Then the thing became a fad. We are still in this stage, and of course are paying fad prices. It might be possible that a good all-leather dress shoe cannot be retailed for less than \$8 a pair, but certainly this is a high figure when the soles are of rubber. Necessity for the craze has now passed. People know that a first quality sole can be made of rubber, and the next thing is to bring it down within range of their buying power.

The chief advantages of the rubber sole over the leather one are:

- (1) Greater wearing power; i.e., longer life.
- (2) Being by nature absolutely waterproof.

The rubber sole properly made will last anywhere from two to three times as long as the leather one. This consideration is by far the most important. Theoretically, for good shoes the uppers and the soles should wear out at about the same time. Ordinarily a shoe will stand at least two more sets of leather half soles and heels. Consequently with a good rubber sole this theoretical condition is more nearly approached.

Leather is a porous, fibrous substance and to be made waterproof requires the use of large quantities of various waxes and greases. Rubber is non-porous and watertight by nature. This fact constitutes the main objection to the rubber sole, for not only is it watertight, but airtight as well. It is claimed that leather allows the feet to breathe and in this way prevents burning. However, this is really only a minor point and can be remedied by using canvas uppers or by some form of a ventilator.

Another objection is that a rubber sole tends to slip on a wet pavement. With the first ones it was hardly possible to walk with them on rainy days. This trouble has now been almost entirely done away with by incorporating into the rubber cotton fiber or ground leather, or both. Consequently as the sole wears away a surface is produced which will absorb a little water and thus prevent slipping.

The first rubber soles were quite heavy. It did not seem possible to prepare a stock with the desired stiffness, strength, and quality without having it also of high specific gravity. This was not to be thought of, for the addition of even half a pound to the weight of one's shoes has an effect quite noticeable at the end of a day's work. The introduction of ground cotton waste and leather dust as compounding ingredients made it possible to bring the gravity down to 1.25-1.35.

The manufacture of soles is quite simple. It may be outlined as follows:

(1) *Preparation of the cotton fiber:* Various kinds of rags and trimmings, depending mostly on the color and quality of the sole, are put through a shredding, grinding, and fluffing process. In the end the fibers are reduced to not much more than 1/32 in. in length.

(2) *Preparation of leather dust:* Trimmings from the shoe factories and repair shops are ground very fine, and usually are air separated. It is customary also to make up a master rubber by milling in a considerable percentage of the dust and refining it a number of times to remove the lumps. This master rubber is weighed up and mixed as usual in the main batch.

(3) *Rubbers:* Depending on the quality of the sole more or less rubber and shoddy are used. These are of the common grades. The shoddies must, however, be of low gravity. The backbone of the sole business is reclaimed auto-friction. This is the rubber-coated duck used in the building of the carcass of auto tires. Whether this building is done by hand or by machine there is an enormous amount of trimmings to dispose of. These trimmings carry quite a lot of unvulcanized rubber, which is of better quality and higher purity; i.e., with less compounding material, than that of any other place in the tire. The rubber is either reclaimed by a modified acid process or extracted with solvents. In the latter case both the rubber and the fabric is usable, whereas in the former the cotton is destroyed. However, the extraction process requires very careful supervision to be profitable, and it is a question as to which



method is the more economical. The reclaimed rubber is of high quality and low gravity, and makes a highly satisfactory sole. As would be expected, by far the largest portion of rubber soles and heels are made by the large tire companies.

(4) *Milling*: The actual preparation of the batch is not difficult and is carried out on ordinary rolls in the usual manner.

(5) *Calendering*: The stock is plied up very carefully to the desired thickness and sent in rolls to the cutting room.

(6) *Cutting*: The soles are stamped out by means of dies in a cutting machine. The dies are carefully adjusted so that there shall be but very little overflow during the cure.

(7) *Muring*: This is accomplished in molds in the usual way. The trademark, name of maker, and any special marks are put on in the mold. The cure is usually short but with a high steam pressure. 25 minutes to 60 lb. is not uncommon.

(8) *Trimming*: Usually done by girls, on regular trimming machines.

(9) *Varnishing*: Accomplished ordinarily by dipping. Either a spirit or water varnish may be used. It gives the sole a nicer appearance and prevents blooming.

Following drying, the soles are ready to be packed and shipped to the shoe makers.

A good sole will have a tensile strength slightly in excess of 1000 lb. per square inch, but will have a very low stretch. It must not be brittle nor break across when given a surface cut and then bent double.

For very rough, heavy shoes, such as are worn by teamsters, iron workers, and railroad section men a new sole is coming into favor. It consists of a number of plies of heavy duck built like a belt, and stamped out to size with a die. Rubber or balata is used to cement the plies together. Such soles have rather unsightly edges but from the standpoint of service they are very satisfactory.

To the keen observer it must be apparent that leather shoes are going, in fact have gone, beyond the means not only of the poorer classes but that of the better middle classes as well. War conditions and speculation are largely to blame. It is the American way to beat such a condition not entirely by legislation but by invention—invention of a substitute.

A number of rubber soled shoes with canvas uppers are now being placed on the market. Canvas uppers can be waterproofed if desired in a number of ways. For instance, they can be waxed, rubber coated, or built of three plies, the inside one of fabric which has been frictioned and skim coated on both sides. The present offerings are but feelers which will, no doubt, be followed up with a good, all-around canvas-rubber shoe. Such a shoe must be neat appearing, serviceable, and have a long life. There is certainly no reason why it cannot be made.

**Steam Packing.**—French chemists have found a specimen of klingerite (a German steam pipe joint packing) about a sixth of an inch thick to consist of 15 thicknesses of thin asbestos. Analysis showed 80.5 per cent of asbestos, 2.2 of cellulose (flax), and 17 of rubber and balata, with a small proportion of sulphur.

## Modern Concentration of Colorado Tungsten Ores—II

By S. Fischer, Jr., Ph.D.

(Concluded from Vol. XVI, p. 565)

### The Black Prince Tungsten Mill

This mill is situated at Ferberite in Boulder Canyon about seven miles from Boulder, Col. The plant handles its own ores from the group of the Black Prince mines, many of which are operated by leasers. The ore runs from 1.5 to 60 per cent tungstic acid, the high-grade material being shipped directly without passing through the mill. The capacity of the mill is 25 tons per day. It is at present contemplated to increase the capacity of the mill to 75 tons per day. The concentrator is operated by electricity, the power coming from the Colorado Power Co. The mill uses three Westinghouse motors of 15, 7.5 and 10 hp.

The general flow sheet of this concentrator is similar to those shown with the exception, that a Denver quartz mill is used for fine grinding instead of a ball mill. This mill is of the Chilean type and it is claimed gives very satisfactory results in this instance, producing a very uniform product of the desired mesh. Fig. 1 shows the flow sheet of this mill.

The ore from the mine run passes to an 8 in. x 12 in. Denver steel crusher, the oversize passing to a set of 12 in. x 20 in. McFarlane-Eggers rolls from where it is elevated to the fine ore bin together with the undersize from the crusher. The material from this bin is fed to a No. 2 Denver ore feeder and goes to a 12 in. x 12 in. Richards jig. The jig concentrates are collected, dried and sacked for shipment. The tailings from the jig go to a No. 1 Denver quartz mill where a 30 mesh product is obtained. This product then passes to a Loves classifier and dewatering device. The overflow and slimes from this last combination are fed to a Callow cone, from which the overflow is conducted to the canvass plant and the thickened slime to a Monell slimer.

From the first dewaterer the coarse pulp is conveyed to one side of an Isbell concentrator, the high-grade concentrates are collected, the middlings pumped back

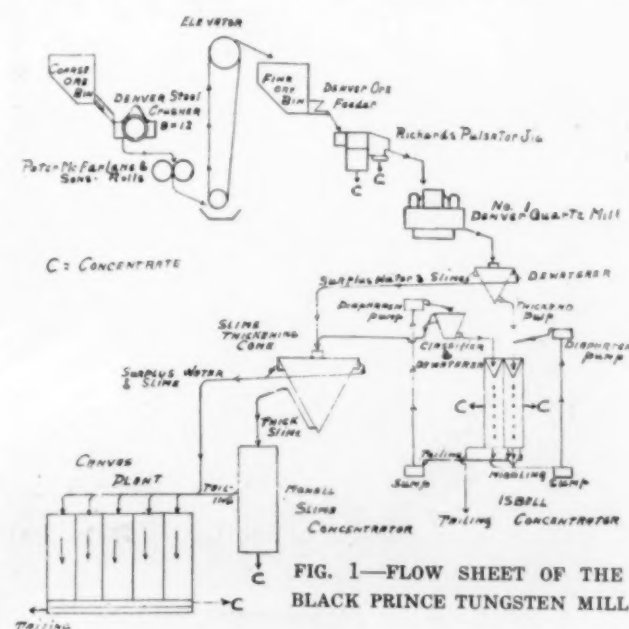


FIG. 1—FLOW SHEET OF THE BLACK PRINCE TUNGSTEN MILL





minus 12 mesh product from the vibrating screen passes directly to the classifier.

The hydraulic classifier yields three products: the first ranges from 12 to 50 mesh, the second from 50 to 80 mesh and the third is minus 80 mesh. All these products go to three Wilfley tables where only the concentrates are collected, the rest of the material passing to an Akins classifier. This latter gives sand, an intermediate product, and slimes. The sand circulates between a ball mill and the classifier until slimed, when it is distributed to two Wilfleys. The slimes and the intermediate product go to the same tables without any further treatment. The concentrates from these tables are collected for shipment. The middlings return to the classifier and the slimes go to a Callow tank. The over-flow from the Callow enters the "rag plant," while the underflow is passed over a Monell slimer, the slimes from this then going to the "rag plant."

The "rag plant" consists of two tiers of six tables each. The lower tables are 6 ft. x 36 ft. while the upper ones are 6 ft. x 26 ft., thus giving a total canvass area of 2232 sq. ft. The slimes from the "rag plant" go to waste, while the low-grade concentrates pass over a Monell slimer giving a 60 per cent concentrate and tails which are returned to the "rag plant." The mill endeavors to produce 60 per cent concentrates throughout the operation, which are sold to the Tungsten Products Co. of Boulder. The ore treated at this plant averages about 7 per cent tungstic acid. Fig. 4 gives a general view of the mill.

Some features at this mill are worthy of notice. The Denver quartz mills used are employed as intermediate grinders only, the Dewco ball mill doing the final fine grinding. It is claimed that with this arrangement the large bulk of material handled per day is crushed to the fine state in a shorter time than if the quartz mills were used alone. The rag plant circulating system is the other item worthy of notice. Finally it should be stated that the flow-sheet presented in this article is not the one embodying the mode of operation at the time of the author's visit, but is that of the final mill, including new features and machines.

#### The Mill of the Rare Metals Ore Co.

Both from an engineering and an efficiency standpoint this mill undoubtedly is one of the finest examples

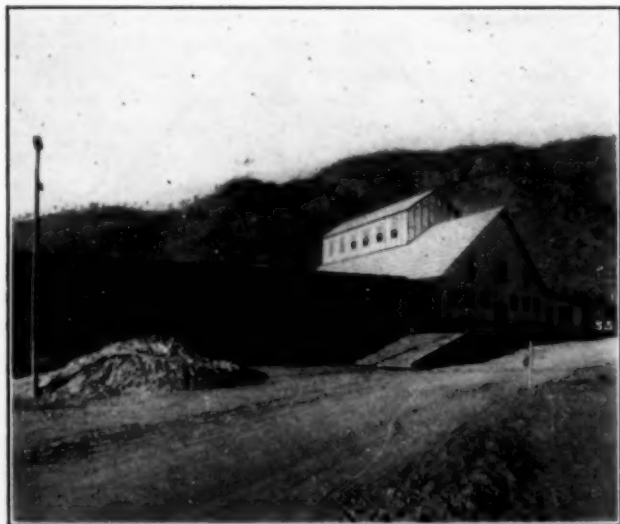


FIG. 4—LUCKIE 2 MILL

of the district. The mill treats custom ores and is able to handle 50 tons of 1.5 per cent material or 25 tons of 4 to 5 per cent ore. The practice at the mill is to state the number of units of tungstic acid handled per 24 hours rather than the tonnage of ore treated in the same length of time. In other words the plant handles 100 to 150 units of tungstic acid per day. The average mill ore runs 4 per cent tungstic acid.

Due to the fact that this mill is a typical example of efficient engineering its flow sheet was given at the beginning of this paper (see this journal, May 15, 1917, Fig. 1, p. 560). The flow sheet may be divided into two concrete parts, the sampler flow sheet and the mill flow sheet. On entering the mill, the ore is weighed and transferred to receiving bins. From these bins the product is passed through a 10 in. x 16 in. Blake crusher where the ore is reduced to 1.5-in. size. No. 1 elevator raises the crushed material to a set of rolls (14-in. x 27 in.) reducing the product to  $\frac{1}{2}$  in. This  $\frac{1}{2}$ -in. material is sampled by a 36-in. Vezin sampler, which takes a 1/5th cut. The reject goes to the No. 2 elevator from where it is passed into the mill bin, containing as a maximum size  $\frac{1}{2}$ -in. ore. The sample from the Vezin passes through a set of 12 in. x 20 in. rolls where a reduction to  $\frac{1}{8}$  in. size takes place. This material is again sampled by a 20-in. Vezin taking a 1/5th cut. The reject passes to the No. 2 elevator and from there to the mill bin. The second sample is coned and quartered to a 20 lb. sample, dried, ground and rifled to assay pulp.

From the mill bin the ore passes into the mill proper through a plunger feeder which feeds to the No. 3 elevator. From here the product goes to an impact screen with  $\frac{1}{8}$ -in. openings. The oversize from the screen is passed through the No. 1 set of 14 in. x 27 in. rolls from where it goes back to the No. 3 elevator. The undersize from the impact screen is fed to the No. 2 impact screen having 1/16-in. openings. The oversize from this screen passes to a two-compartment Hartz jig, which gives concentrates, a hutch product and a third product which latter passes over a dewatering screen and from here goes to the No. 2 5.5 in. x 20 in. high-speed rolls which reduce the product to 1/16-in. size. This then enters elevator No. 3 to continue its passage through the mill.

The underflow from the No. 2 impact screen goes to a two-compartment hydraulic classifier the overflow of which is conducted to a 36-in. Akins classifier. The underflow of the one compartment of the classifier unites with the hutch product from the Hartz jig and goes to the No. 1 Wilfley table. The underflow from the other compartment of the classifier goes directly to a No. 2 Wilfley. The Hartz concentrates are collected, dried and sacked. The same holds true for the concentrates from the first two Wilfley tables. The middlings from No. 1 and No. 2 tables pass through a hydraulic pipe classifier, giving a spigot concentrate running between 55 and 60 per cent tungstic acid. The second product of this classifier goes back to elevator No. 3.

The Akins classifier receives material from the dewatering screen from elevator No. 4 and from the ball mill. It yields three products, the slimes of which go to the Callow tanks, the intermediate product which are classified and the sands which are slimed in the ball mill. The ball mill, which is of the Colorado Iron

Works type, is 4 ft. x 3 ft. and is in closed circuit with the Akins classifier and elevator No. 4.

The slimes after treatment in the Callow tanks yield two spigot products, each of which goes to a separate Deister slimer, the concentrates of which are collected, the middlings going to elevator No. 4, while the tailings go to the "rag plant." The overflow from the Callows unite and enter the "rag plant." The intermediate product from the Akins is classified in a hydraulic classifier, the spigot product of which goes to Wilfley table No. 3 while the overflow goes to Wilfley No. 4. The distribution of the table products is identical with those obtained on the Deister slimers. The overflow from the sand classifier goes to seven canvas tables each being 6 ft. x 24 ft. and set at a drop of  $\frac{3}{4}$  in. per foot. The spigot product from the sand classifier goes to the tails ponds. The concentrates from the canvas tables are pumped back to elevator No. 4 by means of centrifugal pumps.

This mill produces concentrates of at least 60 per cent tungstic acid content. The extraction is remarkably high, but the writer is not at liberty to give the exact figures. To attain this high mark of efficiency various novel features are connected with the construction of this mill. As is seen from the flow sheet, the sampling of all the ores is accomplished with the greatest of care. The only mechanism which did not come up to the expected standards of efficiency is the distributing elevator No. 2, the moving shute of which is rather a detriment than an asset, due to the wear and the labor involved in its manipulation.

In the choice of the machinery for the mill proper the greatest care has been exercised. While the flow sheet may seem complicated, one is struck with the compactness and neatness of the plant on visiting the same. The whole scheme then seems simple and is readily understood. Attention should be drawn to the arrangement of the No. 1 and No. 2 rolls and of the use of high-speed rolls on the dewatered Hartz jig product. The handling of the middlings from the Wilfley tables No. 1 and No. 2 is novel and affords a considerable saving. This product passes through a hydraulic classifier, designed by the staff of the mill, which is locally known as the "hickey." The spigot product is of commercial grade and saves this material from again passing through the mill.

The treatment of the intermediate product from the Akins classifier is also worthy of notice, as most of the local plants handle only two products from this classifier, the slimes and the sands.

The water supply to the canvass tables at this plant are also distinctive. Instead of having the regular Wilfley type of feed, these tables taper toward the upper end, the water entering at the apex and being distributed at will by movable guides as shown in Fig. 5.

Provisions for cleaning up the mill floor have also been made, the floors being inclined toward elevator No. 4. From time to time the floors are washed with a hose, the material gathered in the elevator and sent through the mill. Even the workmen undergo a daily washing, provisions being made for shower baths. The "efficiency" of this latter process has however not been calculated.

It is really astonishing to see how much one may save by supervising the small losses. For instance, at this plant the ashes from the drying furnaces are saved

every day and when a sufficient amount has been collected it is again passed through the mill. This amount figures approximately 6 lb. of tungstic acid saved per day.

As this plant represents the successful practice in the ore dressing of the Nederland tungsten district, the complete plans of this mill are given in Fig. 6.

### The Tungsten Losses

As has been stated in the earlier part of this paper, as much of the values as possible should be eliminated from the ore before fine grinding. Before the installation of the "rag plant" at the mills the tailings went to waste. These tailings carried values which in the modern practice are to a large extent recovered. Some very careful tests were run on the various tailings according to the various meshes, for the tungstic acid content, just before entering the "rag plant." The results are taken from the tails of the Rare Metals Ore Co.'s mill and are given in the following table:

Mesh	WO <sub>3</sub> Content	Percentage Loss
20-40	0.63	2.0
40-60	0.57	6.9
60-80	0.375	7.0
80-100	0.365	2.0
100-200	0.275	10.1
-200	1.41	66.0
		100.0

These data indicate, that by far the largest percentage of the losses are found in the -200 mesh material. At present, with the use of the "rag plant," the tailings as they leave the mill and enter the settling ponds carry approximately 0.75 per cent tungstic acid as losses. Of these losses 66 per cent are contained in the -200 mesh material. It has been experimentally ascertained, that only 31 per cent of the 66 per cent losses could be recovered in these ponds. This demonstrates the great difficulty encountered in endeavoring to recover any large amount of values from the losses in the finest tailings leaving the mill. It is claimed that the installation of the "rag plant" in a mill saves

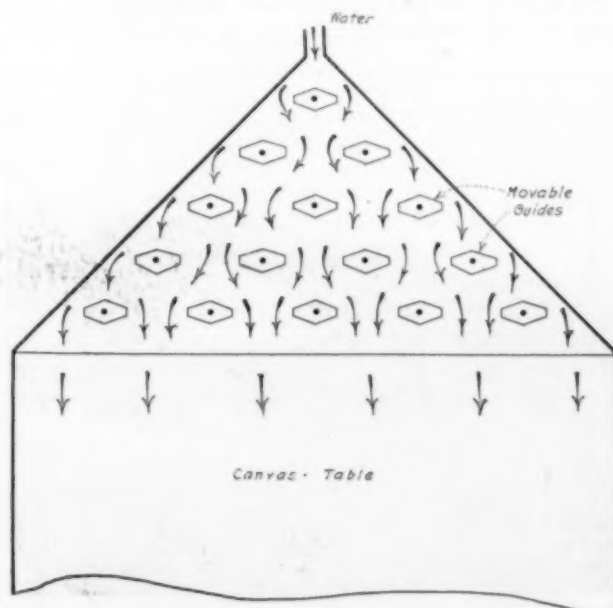


FIG. 5—WATER FEED TO CANVAS TABLE



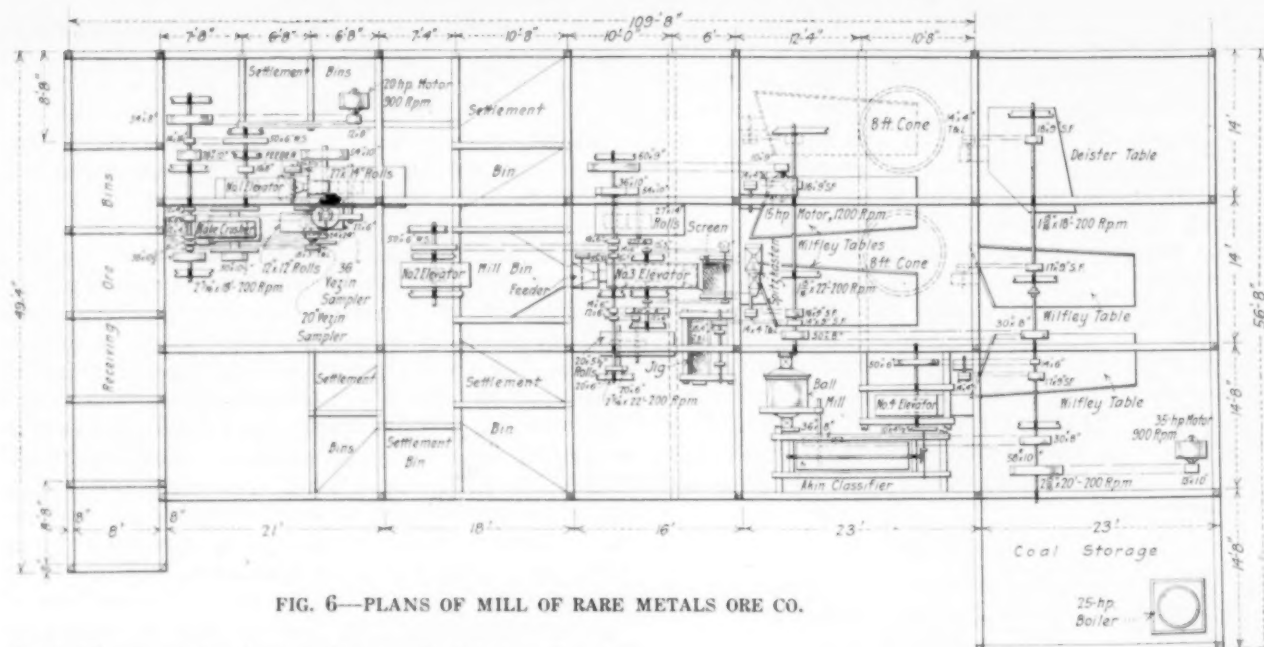


FIG. 6—PLANS OF MILL OF RARE METALS ORE CO.

about 10 per cent, if correctly manipulated. The dewatering of the pulp before sending it onto tables in connection with the installation of a "rag plant" at a concentrator will procure a saving of approximately 15 per cent.

#### Future Improvements in the Ore Dressing Methods of the District

As the ore dressing methods for ferberite ores have reached a high state of refinement, it is hardly possible that there will be any further striking features along the lines of improvements. The main trend will be to increase the percentage of extraction. Endeavors will be made to eliminate more of the values before fine crushing, to dewater the pulp before going over the tables and to cut down the square feet of the canvass in the "rag plant" to a minimum. These little phases will in all probability be kept secret by all the companies, so that new material will be rather difficult to obtain, until that time when such features as flotation and magnetic separation have been more thoroughly investigated.

Attempts to use both flotation and magnetic separation have been made at various mills in the district, but the results obtained seem to discourage either practice. It is, however, unfair to say that both these methods are of no value in the practice of the district. The work done along these lines seems, as far as the writer could discover, insufficient to justify giving a final verdict upon the subject. The ores of the district are rich enough to guarantee enough concentrates for the present. In time, however, the recovery of the values in the very low-grade materials will have to be taken into consideration and then either one or the other or in all probability both of the methods mentioned combined with a previous roast may prove of value.

It might be stated here that the practice in the dressing of tungsten ores as developed in Boulder County is of the highest standard and there is no reason why the same methods of concentration might not be used on any of the commercial tungsten ores, such as scheelite, wolframite and huebnerite. The specific gravity of scheelite varies from 5.9 to 6.1 and that of both

wolframite and huebnerite is 7.2, being practically the same as that of ferberite. The latter mineral is a modification of wolframite with little or no manganese.

#### The Future of the Metallurgy of Tungsten

The main use of tungsten is in the manufacture of tungsten steels for various uses, such as for high-speed tools and as used in the manufacture of ammunition. Furthermore, tungsten has an industrially very important field in the manufacture of filaments for incandescent lamps, though the quantity of tungsten consumed for this purpose, as compared with the consumption for tungsten steel, is insignificant. While the demand for the metal, due to the present war is considerable, the feeling among the miners of tungsten ores is that after peace has been declared, the tungsten market will suffer, due to the lack of demand for the metal or tungsten alloys in the arts. The feeling is prevalent in the district, that more work should be done respecting the use of tungsten in the arts so as to insure the future of the industry. There can be no doubt, however, that tungsten steel will play a very important part in the reconstruction period after the war.

Some think that the greatest danger confronting the tungsten metallurgy would be the discovery of large molybdenum deposits. The one great drawback in the use of tungsten for steel is the large amounts required to produce the desired effects in the steel, and it is claimed that molybdenum on the other hand produces the same qualities in steel using one-third the amount of this metal as compared with tungsten.

Small deposits of molybdenum have been located not only in Colorado but also in other parts of the United States, but from a commercial point of view, their working has received little consideration, due to the small amount of material available. Then, too, the dressing methods for molybdenum ores have not been developed sufficiently to guarantee their economic working. The largest molybdenite deposits so far known are in the Province of Ontario, Canada. These deposits have been studied by the Canadian Bureau of Mines as to their nature and extent. Metallurgical methods best suited for their concentration have been investi-

gated. In tests run at the laboratories of said bureau, and extending over a period of approximately two years, it was found, that the most suitable procedure would be to coarse grind the ore, separate the flaky concentrates as far as possible during this stage, then fine grind the rest of the material and subject it to flotation by water. Extractions as high as 84 per cent were obtained and it is claimed that in practice the percentage extraction would, in all probability, be considerably higher. While the prices of molybdenum, molybdic acid and ferro-molybdenum are higher than the prices for the corresponding tungsten products, the smaller amounts of molybdenum required to produce the desired effects in steel would by far offset the lower prices of the tungsten products. This undoubtedly would mean that molybdenum would be preferred in the steel industry for the manufacture of tool steels and ammunition.

### Conclusion

In conclusion the writer wishes to express his sincerest gratitude to the following gentlemen for their kind assistance and their valuable information: Mr. W. F. Bleecker of the Tungsten Products Co.; Mr. C. A. De Witt of the Woltongue Mining Co.; Mr. J. G. Clark of the Tungsten Production Co.; Mr. G. B. Tyler of the Rare Metals Ore Co.; Messrs. John Connors and T. McGrath of the Vasco Mining Co.; Mr. H. B. Holmes of the Luckie 2; Mr. J. S. Bartley of the Denver Quartz Mill & Crusher Co.; Messrs. H. B. Lowden and R. P. Akins of the Colorado Iron Works and Mr. J. H. Flood of the Hendrie & Bolthoff Mfg. & Supply Co.

### British Standard Nomenclature of Bituminous Material

#### FIRST GROUP—TAR PRODUCTS (PRINCIPALLY COAL TAR AND PITCH)

1. *Tar*.—Tar is the matter (freed from water) condensed from the volatile products of the destructive distillation of hydrocarbon matter, whether this be contained in coal, wood, peat, oil, etc. A prefix such as coal, gas-works, blast-furnace, etc., must be added to the word "tar" to indicate the source of origin.

2. *Pitch*.—Pitch is the solid or semi-solid residue from the partial evaporation or distillation of tar.

#### SECOND GROUP—BITUMENS AND ASPHALTS

3. *Bitumen*.—Bitumen is a generic term for a group of hydrocarbon products soluble in carbon disulfide, which either occur in nature or are obtained by the evaporation of asphaltic oils. The term shall not include residues from paraffin oils or coal tar products.

4. *Native Bitumen*.—Native bitumen is bitumen found in nature, carrying in suspension a variable proportion of mineral matter. This term shall not be applied to the residuals from the distillation of asphaltic oils.

5. *Asphalt*.—Asphalt is a road material consisting of a mixture of bitumen and finely graded mineral matter, ranging to such a size as will pass through a sieve having square holes of  $\frac{1}{4}$ -in. side.

6. *Native or Rock Asphalt*.—Native or rock asphalt is a rock which has been impregnated by nature with bitume.

The committee recommends that prefixes denoting the source of origin should be attached.

## The Possibilities of Developing an American Potash Industry<sup>1</sup>

By Richard K. Meade

About a month ago this paper was started by quoting Professor Ostwald's well known remarks concerning Germany's ability, through her control of the only known large deposit of potash salts, to say which of us "uncultured" nations could eat and which would do without our meals. Since making this beginning, however, we have read about a dozen papers on potash and several prospectuses of proposed potash producers, all of which have taken great pains to quote the professor and generally to show him the error of his ways; hence I have recast my introduction and will only refer to Ostwald's remarks by saying this: I know of some millions of dollars which would be invested in establishing a potash industry in this country if we could be sure Germany would be inclined to exact stiff terms from the United States, or dictate that she should go hungry. The thing which keeps this money out of such an investment is the fear, not that we won't have potash from Stassfurt as heretofore, but that we will have too much and that the German producers will be so glad to get Yankee dollars to pay their war debts that they will offer us potash on the same old \$40 basis.

If the American investor after the war can be insured against the dumping of German potash salts into this country at prices too low for us to reach, I know that we can develop a potash industry in this country and in Canada which can more than take care of our needs for both agricultural and chemical purposes, and which can sell potash at a price which will work no hardship on any users. It is my purpose in this paper to outline the sources from which it seems most promising to produce American potash.

The present methods employed for obtaining potash in this country may be grouped under four general heads.

1. By the evaporation of the brines from various lakes and marshes.
2. From kelp and the ashes of various plants.
3. As a by-product of various industries, chief of which are the cement, iron, beet sugar, and molasses industries.
4. By the decomposition of silicate rocks, chief of which are alunite, glauconite and feldspar. Numerous other silicates are also available, among which are leucite and sericite.

#### BRINES AND LAKES

It is natural that the first attempts to obtain potash in this country were connected with the evaporation of brines from various lakes in the western part of the country. Geological Survey reports, even before the war, had called attention to the large amount of potash contained in the waters of some of these lakes, notably Searles Lake, in Southeastern California, which has been made the subject of extensive investigations on the part of the United States Geological Survey. The American Trona Corporation was organized in 1913 to exploit this lake, and had planned to spend something like \$3,000,000 to build a railroad and to install the

<sup>1</sup>A paper read at the Buffalo Meeting of the American Institute of Chemical Engineers, June 22, 1917.

necessary machinery to recover borax and potash from this water. At that time, particular stress was laid on the borax rather than on the potash.

Searles Lake is located in the extreme northwestern part of San Bernardino County in southeastern California about thirty miles from the Southern Pacific Railway, at Searles. It consists of a dry bed of crystalline salts, hard enough to support a wagon and team. It occupies an area of from eleven to twelve square miles and has a depth of approximately 70 ft. The deposit contains a saturated brine in the interstices between the crystals, estimated to be 25 per cent of the volume of the bed, and carrying approximately 2.1 per cent potash (equivalent to 4 per cent potassium chloride) and about 1.3 per cent borax. An analysis (W. Van Winkle) of the solid matter from the water is given below:

	Per cent
K .....	6.34
Na .....	33.80
Cl .....	37.04
SO <sub>4</sub> .....	13.00
CO <sub>2</sub> .....	7.24
B <sub>2</sub> O <sub>3</sub> .....	2.50
Other constituents .....	0.08

By reference to the analysis above, it will be seen that the principal products obtained are potassium chloride, borax, soda ash, salt, and sodium sulphate. Of these products the salt will be largely in excess of all others.

I understand that the American Trona Corporation has expended \$2,500,000 to date in developing this property, of which \$600,000 has been spent for the construction of a 30-mile railroad connecting the lake with Searles, on the Southern Pacific Railroad. The company has built two plants, one at Trona, where the brine is evaporated, and the other at San Pedro, Cal., where the solid salts obtained from the evaporation are separated.

The American Trona Corporation has shipped quite a large quantity of potash in the past year. I understand that from the chemical standpoint, an objection is raised to their product owing to the sulphates and borax which it contains, and I am also informed that the fertilizer people have objected to the product on account of the borax.

There are numerous small lakes in the region of the Sand Hills of Nebraska, the waters of which are more or less alkaline and also contain potash. This potash is believed to have resulted from the leaching of the ashes from numerous forest fires which have occurred in that section. The larger and deeper of these lakes are only slightly alkaline and the only ones which are at all rich in alkali are the small lakes.

The Potash Products Company, of Omaha, Neb., has been for some time a producer of potash which they obtain by evaporating the water from Jesse Lake, situated in this section. This lake covers 240 acres and is located 300 miles west of Omaha, and 3 miles from Hoffland. The lake is underlaid with a dark greenish-colored mud, beneath which is a sand bed 20 ft. thick, strongly impregnated with brine of greater concentration than the surface waters. This brine contains about 13 per cent solid matter, of which from 25 to 30 per cent is soluble K<sub>2</sub>O. The Potash Products Company

has a capacity of about 75 tons of dry salts daily, their product will probably average 28 per cent K<sub>2</sub>O, so their total output is approximately 21 tons of K<sub>2</sub>O per day. No attempt is made to separate potash from the other salts, and the material is shipped as evaporated. The potash is in the form of carbonate, and the product also contains a large quantity of the carbonate of soda.

Other small lakes are being developed by the Hord Alkali Products Company of Lakeside, Neb.

The officials of this company inform me that it owns about 50,000 acres of land in which these alkali lakes are located, but that their development work has been carried only a year in advance of their requirements. This company began construction of an evaporation plant about a year ago, and started operation Jan. 1, 1917. Their plant has a capacity of from 40 to 50 tons of product per day, working on brine of about 1.075 sp. gr. This brine is pumped from wells located in lakes, the surface water of which is comparatively fresh (containing less than 1 per cent of solids). The plant itself is located on the main line of the C. B. & Q. R. R. at Lakeside. It is equipped with triple effect evaporators for preliminary concentration, and single effect for the salting out. The concentrated salts are fused to a clinker in a small rotary kiln, ground in a Stedman disintegrator, and packed in sacks of approximately 200 lb. each. The product has the following general composition:

	Per Cent
Na <sub>2</sub> O .....	33.30
K <sub>2</sub> O .....	21.82
SO <sub>4</sub> .....	16.98
Cl .....	4.22
CO <sub>2</sub> .....	21.87
Loss on ignition.....	1.50
Insoluble in water.....	1.25
	<hr/> 100.94

This region is entered by the Chicago & Northwestern R. R. and by the Chicago, Burlington & Quincy R. R., so that the transportation facilities are excellent. Unfortunately the supply of brine in these lakes is very limited. It is estimated that Jesse Lake, the largest of them, contains approximately 28,000 tons of K<sub>2</sub>O.

There are a number of other companies throughout the west who are experimenting on the production of potash from brines. One of these companies is the Inyo Development Company, who has a small experimental plant and are planning to develop the potash resources of Owens Lake.

Owens Lake is situated south of Mt. Whitney and northeast of Death Valley, Cal. The lake is 27 miles long and 23 miles wide, and is estimated (H. S. Gale) to contain 3,000,000 tons of potash. An analysis of this water is given below:

	Per Cent
NaCl .....	39.51
Na <sub>2</sub> CO <sub>3</sub> .....	41.34
NaHCO <sub>3</sub> .....	4.41
K <sub>2</sub> CO <sub>3</sub> .....	2.21
Na <sub>2</sub> SO <sub>4</sub> .....	12.06
Other constituents .....	0.16

Several thousand tons of soda ash have been made at Owens Lake, and it is proposed to recover the potash



from the spent waters from the soda ash manufacture. These waters were formerly wasted and contained about 4.25 per cent  $K_2O$  in the form of carbonate.

Another lake which it is proposed to develop but towards which I believe no material steps have been taken at the present time—is Summer Lake, in Oregon. This is about 30 miles from Pleasant View, Ore. The water is very similar to that of Owens Lake as will be seen from the analysis below:

	Per Cent
NaCl .....	27.10
$Na_2CO_3$ .....	43.91
$NaHCO_3$ .....	21.41
$KCO_3$ .....	3.63
$Na_2SO_4$ .....	2.21
Other constituents .....	0.87

There has been some attempt to develop a potash industry in connection with the Great Salt Lake, in Utah. The Utah Chemical Company is reported to be erecting a plant to make potash from the bitterns obtained as a by-product from the manufacture of solar salts from the waters of the Great Salt Lake. This plant is largely an experimental one.

By referring to the above it will be seen that practically all of the above developments during normal times would be limited largely by the capacity of the plant to get rid of other products than potash. There is also the objection that none of these waters will yield potassium chloride without treatment with reagents. The Nebraska Lake propositions, which would promise most under normal conditions and which are reported at the present time to be making a large amount of money, are quite limited as to brine supply and unquestionably they could only furnish a very small part of the potash which has been shipped to us from Germany.

The developments at Searles, Owens and Summer Lakes will depend almost entirely on the Pacific Coast market for soda ash and salt cake, and it is hardly probable that under normal conditions the market in that section will be sufficient to dispose of any very considerable quantity of these products. In the case of both Owens Lake and Summer Lake, the quantity of soda to be disposed of is so very much larger than that of potash, that they probably would never amount to anything more than very small potash producers. Against Summer Lake is also the difficulty of transportation and of obtaining labor, and the high cost of fuel.

The nearest soda ash plant is at Hutchison, Kan., but it is probable that this latter plant would cut them off from any trade East of the Pacific states, so that their market for soda ash would be almost entirely confined by adverse freight rates to the Pacific Coast. Even when it came to shipping potash to the East, they would have a very considerable freight rate (about \$6.00) to overcome.

#### KELP

The fact that the giant kelps of the Pacific Coast are rich in potash has long been known. As early as 1911, kelp was gathered and dried by the Pacific Mulch Company, Terminal Island, Cal., but no effort was made by this company to do anything more than harvest the kelp, partially dry it, and chop it into pieces from 6 in. to 8

in. long. In the 1913 *Mineral Resources* the United States Geological Survey reported that a number of companies had been formed to engage in the kelp industry. At that time, however, no effort was being made to extract potash salts from kelp, and attention was entirely devoted to the harvesting, drying and grinding of the kelp.

I believe that the American Potash Company was formed prior to the war and was the first company actively to attempt the production of potash from kelp. This concern had a plant at Long Beach, Cal., where they harvested and dried kelp, using an oil-heated rotary dryer for the latter purpose. Some dried kelp was sold as such, while the rest was burned in a reverberatory furnace, the potassium chloride and sodium chloride leached out of the ash, and separated from each other by fractional crystallization. The American Products Company, Pasadena, Cal., later bought the effects of the American Potash Company, and moved to the property of the latter. This new concern was said to be financed by Mr. George Simmons, of the Simmons Hardware Company, St. Louis, and it was reported that their main idea was to carry out a process worked out by Mr. Isaac Naylor, in which the kelp was to be so treated that a celluloid composition for knife handles, etc., would be the main product, and potash would be obtained as a by-product. Little information is available as to the operations of this company.

Swift & Company, of Chicago, leased a small plant at San Diego and are harvesting and drying kelp. They make no effort to extract the potash, but are simply drying the kelp and shipping it to their fertilizer factories in the East, where it is used in the manufacture of mixed fertilizers. This plant is interesting as it is said to represent the best methods yet tried for drying kelp mechanically. The old plant consisted of two rotary dryers, one 54 in. in diameter by 35 ft. long, and the other 60 in. in diameter by 40 ft. long. The wet material was fed into the cold end of the larger dryer, dropping out from the hot end, and was thence conducted by a belt conveyor into the hot end of the small dryer, leaving the latter at the cold end. The product, which contains 10 per cent water, is ground in a swing hammer mill, and sacked. The dry product contains the whole body of the kelp (including the nitrogen) and averages 15 per cent water-soluble  $K_2O$ . Swift & Company have now built a large plant containing ten direct heat dryers, 60 in. in diameter by 40 ft. long, employing crude oil for fuel. The buildings are of steel; electric drives and modern equipment are employed throughout. The plant is designed to treat 200 tons of wet or 20 tons of dry kelp per day.

The Hercules Powder Company have the only large plant on the Pacific Coast at the present time for actually obtaining potash salts from kelp. Their plant is located at Chula Vista, Cal., and represents a splendid example of chemical engineering ingenuity, although it is probably only a war-time proposition. The products obtained are potassium sulphate and acetone. The kelp is harvested by machinery and is ground by the harvesters to a thick, viscous mass. This latter is pumped into digestion tanks and fermented, whereby the slime and other organic matter form into acetic acid. This acetic acid is neutralized with calcium carbonate and converted into sodium acetate by sodium sulphate. This latter is a waste product from the ace-

tone plant. The liquid is then evaporated and the sodium acetate crystallized out. The potash is obtained 80 per cent pure, while the sodium acetate is recrystallized and then used in the manufacture of acetone. This plant is handling about 1500 tons of wet kelp per day, obtaining from this about 18 tons of potash and 24 tons of acetic acid. The process of clarification, sedimentation, etc., is very similar to that used in sugar manufacture.

The U. S. Department of Agriculture is now investigating with a full-sized plant the possibility of the destructive distillation of kelp. The products obtained are gas, tar, ammonia, iodine, charcoal and potash. The gas will be used to heat the retort, and the potash will be leached from the charcoal.

The possibilities of the production of potash salts from kelp on a large scale do not seem to be particularly bright as a post-wartime proposition. The artificial drying of the kelp represents a large undertaking, since 20 tons of potash require handling something like 1500 tons of wet kelp, containing 1350 tons of water. The plant required to conduct such a large drying operation is considerable, and the type of rotary dryers employed seldom show an efficiency of more than 70 lb. of water per gallon of oil burned, or about 38,000 gal. of oil for 1500 tons of kelp. The cost of this amount of fuel alone under ordinary conditions would eat up most of the price obtained for the product. With destructive distillation and the employment of the gas to help heat the retort some saving in fuel could be effected, but we doubt if this saving would prove very considerable. We also doubt the value of the charcoal. After the potash had been leached from it, this charcoal would unquestionably contain considerable water, and if it is anything like the similar residue obtained in the paper industry, no use could be found for any considerable quantity.

The manufacture of acetone from kelp is manifestly a war time industry, so that potash as a by-product from this industry is not likely to survive the need of acetone for making smokeless powder.

#### BY-PRODUCTS OF OTHER INDUSTRIES

It has long been known that potash was among the volatile products passing off in the waste gases from a number of furnaces, notably from the rotary cement kiln and from the blast furnace. The writer made some experiments as far back as 1903 at the plant of the Dexter Portland Cement Company, to determine the effect which the ash of the fuel had on the cement, and particularly the percentage of ash which entered the cement during burning. Among other things which were disclosed by this investigation, was the fact that there was a considerable proportion of both potash and soda volatilized in the rotary kiln. My investigations at that time were made on a 6-ft. x 60-ft. rotary, and I found that approximately 50 per cent of the potash and about 25 per cent of the soda was volatilized. The results of the writer's experiments were given in a paper read at a meeting of the American Association of Portland Cement Manufacturers, at Atlantic City, in the summer of 1904, and also in his work "Portland Cement."

About this time Professor Hillebrand, then of the U. S. Geological Survey, found that the raw material contained relatively much more potash than the cement,

and he therefore assumed there must be some loss of potash in the burning of cement.

Mr. Clifford Richardson read a paper at the 1904 meeting of the American Society for Testing Materials, in which he proposed to the cement industry that they collect the potash lost by means of a water spray, and stated that Dr. Hillebrand had applied for a patent upon such a process. We believe, however, that no patent was ever granted. The matter was discussed informally, but it was generally conceded at that time that the cost of collecting this dust with the apparatus then known, namely, water sprays, would far exceed its value, if indeed it could be collected at all.

In southern California there had been considerable opposition from the orange growers to the cement plants owing to the dust which settled on the orange groves. It was claimed that this reduced the value of the fruit. Numerous suits were started, and in order to appease the orange growers the two plants near Riverside undertook to eliminate the dust. The California Portland Cement Company in 1911 installed a system of dry settling chambers followed by water scrubbers at their plant at Colton, and the Riverside Portland Cement Company in their plant near Riverside installed even prior to this a Cottrell electrical precipitation treater, which latter was then largely in the experimental stage. The Riverside people persisted, however, in the use of this treater, and gradually developed it into a very efficient method of catching the dust. By this means they were able to recover 95 per cent of the dust formerly lost from the kilns. It was found that in this dust was from 80 to 90 per cent of the potash volatilized in the kiln. Unfortunately, however, the raw materials at that time in use at Riverside were quite low in potash and the dust obtained from the last part of the treaters averaged only about 4 to 5 per cent potash and that from the first part materially less than this, practically all of which was soluble in water.

In order to obtain a material richer in potash all of this dust was fed to a supplementary kiln and was burned to cement in that kiln. From this kiln, dust was obtained running in excess of 30 per cent  $K_2O$ , but it was found that most of the potash in the dust fed into the kilns did not volatilize but remained with the clinker, due no doubt to the fact that the potash was present in the dust as sulphate.

When fertilizer companies began to purchase low-grade material for potash, one of the first substances which attracted their attention was the crust which collects on the side of the stacks of the rotary kiln, and which falls down at intervals into the dust chamber, its high potash content having been pointed out by the writer in the paper mentioned above and also in his work on Portland cement. They persuaded a number of the cement manufacturers to save this crust, which they purchased at prices ranging from \$1.50 per unit in the early days of the war to \$3 per unit later on. This dust averaged 6 to 8 per cent of water-soluble potash.

The Security Cement & Lime Company are among the cement companies who sold their flue dust. They were located near the heart of the fertilizer manufacturing district. Their manager, Mr. J. J. Porter, after seeing the installation of the Cottrell system at the first chemical show, was very much impressed with the possibility of catching all of the dust from the stacks. He re-



turned home and made investigations which demonstrated that they could expect to obtain quite a high percentage of potash in this dust. He then visited Riverside and investigated the process there, and as the result of his investigation persuaded his company to install the Cottrell process, not with a view of eliminating the dust—as they were meeting no trouble from this source—but with a view to catching the wasted potash. Their plant was put in operation in the summer of 1916. Numerous difficulties were encountered at the beginning, most of which have been satisfactorily eliminated.

One very peculiar situation presented itself which had not been foreseen. At the plant of the Riverside Portland Cement Company at Riverside, practically all of the potash in the dust was in the water-soluble condition. When the treaters were put in operation at Security, it was found that only a little more than half of the total potash in the dust was water-soluble, and that while the dust contained from 12 to 15 per cent total potash it contained only about 6 to 7½ per cent of water-soluble potash. The only explanation which could be offered to account for the difference in the state of the potash at the two plants is that at Security the cement is burned with pulverized coal and at Riverside with oil. It appears, therefore, that chemical combination takes place between the products of combustion and the potash.

It is found, however, that all of the potash in the dust may be dissolved by prolonging the digestion with the hot water and by digestion under high pressure. It is also readily soluble in acid. In making mixed fertilizers with this dust, it was found that a considerable portion of this potash was rendered soluble when the dust was mixed with acid phosphate.

It has, of course, been known that chlorides will increase the volatilization of potash. Numerous experiments were made at Security to increase the liberation of potash from the raw material and also to prevent its production in an insoluble form. One scheme was to inject sulphur dioxide into the kiln. The plan, however, which has proved most successful, is to introduce a small amount of salt with the raw material and also with pulverized coal. When the treater was first placed in operation the average water-soluble potash in the dust was about 6 per cent, but since the introduction of the salt the quantity has been increased to 8½ per cent. Patents have recently been granted to Huber and Reath (Nos. 1,194,344 and 1,219,315), who propose to use calcium fluoride in place of salt. They claim that the latter is entirely recovered by the treaters so that only a very small quantity of this mineral is needed, the original charge passing around in a cycle as it were. This process is in use at the Riverside plant, and it is claimed 90 per cent of the potash is volatilized where it is used.\*

The installation at Security was followed by one at the Duluth plant of the Universal Portland Cement Company with a view of eliminating dust only. At this plant very little potash is obtained, and I believe no effort is made to market the dust. This is due to the fact that slag (which here takes the place of the clay element of the cement mixture) contains practically no potash.

At the Alpha Portland Cement Company the waste gases from the kilns are first led through water-tube boilers and thence into Cottrell treaters. At this plant the percentage of potash in the dust is very low, containing about 8 per cent total potash, while only about 2½ per cent of this is water-soluble. It was found that the percentage of water-soluble potash was increased very largely by the use of salt, but, unfortunately, this salt collected on the tubes of the boilers and interfered with the steaming properties of the latter, so that this addition is no longer made at this plant.

The Santa Cruz Portland Cement Company, Santa Cruz, Cal., have been experimenting for the past ten months with one of their kilns, and have been making nearly 700 lb. per day of potassium sulphate, 80 to 90 per cent  $K_2SO_4$ . The details of their process are not now for publication, but they do not employ the Cottrell dust precipitation system. They state that they consider their process a success and propose shortly to install their system on all their kilns.

At the present time installations of the Cottrell system are being made at quite a number of plants with a view of obtaining a dust high in potash which can be sold to the fertilizer trade.

The soda as well as the potash is volatilized to some extent, so that the dust will contain some water-soluble soda. Usually the proportions are about 1 to 4 or 1 to 3. When salt is used in the raw materials the proportions are much smaller.

As we said in the earlier part of this paper that practically all the potash in this dust could be slowly extracted with water, it is highly probable that *all* of the potash in this material is available for plant food. In addition to the potash this material is rich in lime, therefore we have in this one material two very valuable fertilizer ingredients—lime and potash.

At the present time the fertilizer men are perfectly willing to take this dust carrying as low as 4 per cent  $K_2O$ , but it is extremely doubtful if they will accept it after the war is over and they can get German potash. The objections to the dust are twofold: First, it is of course highly alkaline, containing both calcium carbonate and oxide. When used in mixed fertilizers in large quantity the lime reverts the phosphoric acid to the insoluble form. Second, the dust is too low in potash to permit using it in fertilizers to contain more than 2 per cent  $K_2O$ . Two alternatives suggest themselves—one to educate the farmer to the use of this material *as such*, and the other to extract the potash by leaching and evaporation and market the salt as chloride or sulphate. The latter method has been worked out by Messrs. Huber and Reath at the Riverside Portland cement plant, and is described in the reference given above.

In addition to the experiments mentioned above, the writer has been able to examine samples of raw materials and clinker from some half dozen different plants since the European war. All of these samples show a loss of potash ranging from 1¾ lb. to 2½ lb. per barrel of cement burned, an average of about 2 lb. per barrel. It should be remembered that not all the potash so obtained, however, is water-soluble, but it is all available for plant food, and undoubtedly methods of leaching out the same can be easily worked out if found necessary. The efficiency of a Cottrell treater will range between 95 and 98 per cent of the dust and 80 to 90 per

\*This process has been fully discussed in this journal, Vol. XVI, June 15, 1917, page 701.



cent of the potash. When no treaters are installed the dust losses range from 3 to 5 per cent of the raw material introduced into the kiln.

At the present time the loss of dust at the average cement plant is probably in the neighborhood of 3 per cent, or 18 lb. of dust per barrel of cement. If 95 per cent of this dust and 80 per cent of the potash were recovered, dust would be obtained having approximately 9 per cent potash. Assuming that there could be recovered 1.6 lb. of potash per barrel of cement there would be produced from the cement industry alone 72,000 tons of potash (figured as  $K_2O$ ) per year, or nearly one-third of the before-the-war importations from Germany.

The Bureau of Soils, Department of Agriculture, is at the present time preparing a very extensive report on the potash possibilities of the cement industry, and this report covers the subject of the losses of potash at various plants very completely.

About the time of the beginning of the European war, I made a number of experiments in a small kiln, 2 ft. in diameter x 20 ft. long, to ascertain the possibilities of obtaining potash as a by-product from the cement industry, using feldspar, limestone and iron ore as the raw materials. If iron ore is not used, white cement would be obtained, but it was our idea to come as near as possible to producing the product of most of the cement mills.

These experiments followed two general lines. At first we furnaced at about 800 deg. C. a mixture containing salt or calcium chloride and lower in lime than would be used for cement, leached the resulting soft brown clinker with hot water to extract the potash, mixed sufficient limestone with the residue to make a proper cement, ground, and burned the mixture to cement. The second line of experiments consisted in making up a proper mixture for cement and burning it directly to cement, volatilizing the potash in so doing. We met with a fair degree of success along the second line. With the first process a number of difficulties were encountered. One was that with the best treatment we could give we could not render soluble more than about 60 per cent of the total potash in the feldspar, and that we lost some by volatilization. We found on analyzing the commercial side of the case that it seemed to be a much better proposition to attempt to volatilize all of the potash and make a cement clinker at one operation, particularly as we were able to volatilize about 70 per cent of the total potash, whereas we were never able to render more than 60 per cent of it soluble in the two-stage process. Furthermore, it required very little additional fuel to produce a cement than it did to produce the lighter burned material, and with the latter there was of course the extra fuel needed to burn it to cement. Owing to the large amount of water in the leached material this latter operation required more fuel than would be required to manufacture cement in the first place. To render the potash soluble we also had to use a considerable portion of either salt or calcium chloride, whereas if volatilized we used only a very small quantity. As an example of what we did along the line of volatilizing the potash take the following example: A mixture was made up of three raw materials, limestone, feldspar, and iron ore of the following composition:

	Limestone	Feldspar	Iron Ore	Mix	Cement
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
$SiO_2$ ...	1.02	68.12	16.20	13.40	20.80
$Al_2O_3$ ...	0.40	19.05	1.88	3.78	5.86
$Fe_2O_3$ ...	0.42	1.15	71.98	1.98	3.07
$CaO$ ...	52.20	0.51	0.25	41.77	64.60
$MgO$ ...	1.51	0.47	1.65	1.25	1.94
$K_2O$ ....	0.21	8.52	0.25	1.69	0.80
$SO_2$ ....	...	...	...	...	1.65

These three materials were mixed in the following proportions:

Limestone .....	800 lb.
Feldspar .....	180 lb.
Iron ore .....	20 lb.

These gave a mixture of the analysis shown in the fourth column, and the final cement had the analysis shown in the fifth column.

This cement was found to have excellent physical properties and to compare favorably with any cement at the present time on the market. It was normal in every respect and would have been accepted by any engineer as first-class material.

By referring to the analysis it will be seen that the raw mixture contained 1.69 per cent of potash. As it takes 600 lb. of raw material to make a barrel (400 lb.) of cement, there were charged into the kiln 10.14 lb. of potash for each barrel of cement produced. As the clinker contained 0.80 per cent potash, there was in each barrel of cement 3.20 lb. of potash, making a loss by volatilization of 6.94 lb. per barrel. Assuming a dust loss of 3 per cent or 18 lb. per barrel, this dust should contain 38.56 per cent  $K_2O$ .

The potash volatilized at various plants, as I have said, varies quite widely, ranging from 1.5 to 2.5 lb. At plants where the former amount is lost, recovery would probably give a dust too low in potash for sale in this form. At such plants recovery would have to be followed by leaching. Experiments which we have made convince us that this can be successfully done if proper means are installed. This would give a dust which could be used in the kilns and the potash would be in the form of a salt running 60 per cent to 80 per cent  $K_2SO_4$ .

It should also be borne in mind that there is always the possibility of increasing the liberation of potash by selecting raw materials high in potash. No doubt in many localities a change of clays from one low in potash to one higher would bring about the desired result. In many localities feldspar and sericite are available and might be mixed with the clay without detriment to the cement. Indeed, as I have indicated above, feldspar and iron ore might take the place of clay, or, if a white cement is desired, feldspar alone might be used. At the Riverside plant, feldspar is mixed with the shale to increase the potash in the raw material burned.

The possibilities of developing a paying potash industry in connection with the manufacture of cement are excellent. Unfortunately for the speedy establishment of such an industry, the very high cost of steel plate and structural steel at the present time will undoubtedly keep many manufacturers from installing plants who would otherwise do so. The question, too, is not alone one of price, but also of deliveries. No

manufacturer would care to pay the present high price of steel without assurance that he would also enjoy the present high price for potash. Under normal conditions a treater plant for precipitating the dust from a 3000-bbl.-per-day cement mill will cost about \$190,000 complete, or 10 cents per barrel of annual output, but at the present time the cost will be fully twice this amount.

The dust question has always been one of more or less annoyance. The chance to settle this thing once for all and at the same time obtain a valuable product will certainly appeal to the cement industry. In addition to the Cottrell treaters, I believe that most manufacturers will also install boilers after their kilns to save the waste heat from the latter, which is normally more valuable than the potash. The two installations work very nicely together, as the flues, dampers, fans, etc., of one installation will serve for the other, and the boilers will cool the gases enough to permit the use of very much smaller treaters, since the size of the treaters required is proportional to the volume of gases to be cleaned. The normal cost of boilers and treaters will be about 15 to 18 cents per barrel of annual output, but from 30 to 35 cents per barrel at present prices.

If many cement manufacturers would install boilers and treaters now, even with the present high cost of materials, and could sell their potash for \$3 per unit for one year, they could pay for their plants.

I estimate that it would cost at present prices approximately \$30,000,000 to equip all the cement plants in this country (where such installations would pay) with boilers and treaters, and that for this outlay we would save annually, even in normal times:

72,000 tons of $K_2O$ at \$80 per ton.....	\$5,760,000.00
2,400,000 tons of coal at \$3 per ton.....	7,200,000.00

Total saving.....	\$12,860,000.00
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Even after deducting the cost of operation, upkeep, etc., this would pay a very handsome interest on the investment.

The loss of alkalis in the blast furnace has been known for many years, but no efforts had been made to recover potash up to the outbreak of the war. Mr. R. J. Wysor, then chief chemist but now superintendent of blast furnaces of the Bethlehem Steel Company, had analyzed the dust from the bottom of the stove checker-work and found it to contain 15 per cent of water-soluble  $K_2O$ . Attempts to sell this material prior to the war failed, but with the demand induced by the war it was found readily salable and has been collected and sold ever since.

Mr. Wysor has since that time made a very extensive study of the possibilities of potash recovery from the blast furnace gases at Bethlehem. The result of his investigation is given in a paper read at the February meeting of the American Institute of Mining Engineers in New York, abstracted in our issue of Feb. 15, 1917, Vol. XVI, page 205, and most of the information given below is taken from his paper.

The ores used by the majority of iron manufacturers range from 0.21 to 0.33 per cent  $K_2O$ . Some of the Southern iron ores contain much more, but generally speaking these are high in clay and hence would naturally contain feldspar. Coke generally contains about 0.25 per cent  $K_2O$ , and limestone varies from 0.1 to nearly 1.0 per cent  $K_2O$ . The impure limestones high

in clayey matter usually contain most  $K_2O$ , and dolomites, generally speaking, are higher in  $K_2O$  than are calcites.

Wysor found in the Bethlehem charge 32 lb. of potash per ton of pig iron produced, of which about half came from the ore and a quarter each from the limestone and coke. He found that 20 per cent of the potash remained in the slag, and hence 80 per cent was volatilized, of which the wet scrubbers remove 58 per cent, it going into solution in the water used to wash the gases. The solution is too dilute, however, to permit of the recovery of the potash by evaporation. Wysor estimates that it is possible to recover about half of the total vaporized potash by dry cleaning the gases, using a Cottrell treater instead of the wet washers. Up to the present time only about 4 per cent of the total potash has been recovered and sold, yet the amount of dust so recovered in fifteen months has amounted to 106.3 net tons of  $K_2O$ . It represents only the dust most easily collected at the stoves, boiler flues, and dust catcher. This dust averages about 9.9 per cent water-soluble potash. The dust, unlike that from the cement industry, is not highly alkaline. It is probable that after the war leaching would have to be resorted to.

As in the cement industry, certain advantages other than the recovery and sale of the product are connected with the removal of the dust from the gases, notably the better cleaning of the gases. It seems very probable that the dry method of cleaning will replace the wet method at many furnaces. This would result in the saving of much potash. Assuming a recovery of 10 lb. of potash per ton of pig iron, and an annual production of 25,000,000 tons of pig iron, the annual potash resources of the iron industry would be 125,000 tons of potash, figured as  $K_2O$ .

Our former imports from Germany averaged about 250,000 tons of  $K_2O$  annually, so it will be seen that the cement industry and the iron industry alone might be developed to produce nearly 200,000 tons annually.

The cost of operation of the dry treaters would probably prove less than that of the wet washers now used for cleaning blast-furnace gases, so that the only added cost of potash recovery would be the labor of collecting the dust, leaching, etc., and the fuel for evaporation of the liquid and for drying the salt, which items would be about the same as for cement-kiln dust.

The production of potash from the waste liquor of beet sugar manufacture, molasses, etc., has been treated of in a paper which has been read at the Buffalo meeting of the American Institute of Chemical Engineers, June 22, 1917, and published in METALLURGICAL AND CHEMICAL ENGINEERING, Vol. XVII, July 1, 1917, page 17, so that it is hardly necessary for me to go into this subject at this time. It is estimated that about 2000 tons of potash (figured at  $K_2O$ ) are now being produced annually from this source, one of the largest producers being the Western Alcohol Products Company of Agnew, Cal., and it is said that their output is larger than that of any of the kelp plants on the Pacific Coast.

#### POTASH FROM SILICATE ROCKS

The production of potash from silicate rocks has been the subject of much chemical investigation, and the patent offices of England, Germany and the United States have granted many patents on processes looking



toward this end. One of the oldest of these was granted to F. O. Ward and F. Wynants (English patent No. 3185) in 1857. This process is said to have been tested at that time on a large scale and to have given satisfactory results. It consisted in finely grinding and mixing feldspar, flourspar, and chalk, and after molding the mixture into balls or cakes, heating them to a yellowish red heat. A porous clinker was obtained which on leaching with hot water gave up its alkali. It is interesting to note that Ward, even at that time, proposed to use the residue from which he had leached the potash for the manufacture of hydraulic cement.

It is quite natural that the chemical principles made use of by Prof. Lawrence Smith to attack silicates in his method for determining the alkalies, should have been the subject of much investigation looking toward their application to the liberation of potash from feldspar and other silicates on a large scale; and many patents have been granted making use of the essentials of his methods, but varying the reagents and procedure so as to apply more directly to practical work.

One of the earliest of these patents was that granted to Rodin (U. S. No. 641,406). He used a mixture of powdered feldspar, salt, and lime. This patent has been followed by a large number of others granted for various modifications of the same general scheme in which gypsum, calcium chloride, and other haloid compounds took the place of the salt. Nearly all of these processes make use of lime in connection with the above reagents.

Along a somewhat different line we have another series of patents, the first of which was issued to A. J. Swayze in 1905 (No. 862,676). He proposed to fuse feldspar, gypsum, coal, or coke, in a blast furnace, whereby potassium sulphates would be volatilized. Other patents along this line are those issued to H. E. Brown (U. S. Nos. 1,123,841, 1,123,864 and 1,124,238). Just recently there are a whole series of patents issued to A. C. Spencer and to Spencer and E. C. Eckel, covering the volatilization of potash and the production of hydraulic cements (U. S. Nos. 1,209,220, 1,209,219 and 1,209,135).

In addition to the above general line of patents we have many in which novel methods of attack have been proposed, and in which various valuable by-products would be obtained which would assist in paying for the process.

It has generally been conceded that to make potash from feldspar alone was an almost impossible undertaking under normal conditions and pre-wartime prices for potash. The reason for this may be readily understood when we take into consideration that feldspar as ordinarily mined, without careful sorting and selection, very seldom runs over 10 per cent potash and frequently as low as 8 per cent. At a price of 80 cents a unit, this would allow only \$6.40 to \$8 for the mining or quarrying of the feldspar, its crushing and grinding, the reagents which are to be used with it and the fuel and labor necessary to liberate the potash. In view of the fact that it is generally conceded that feldspar mining will cost approximately \$2 per ton, we have only \$4.40 to \$6 left to carry on the rest of the process and to furnish overhead and profits.

A very much cheaper source of potash than feldspar is the green sand or glauconite of the Atlantic Coastal Plain. The deposits of this mineral are very extensive

and the quantity obtainable is probably greater than that of any potash mineral. My own observations of the New Jersey field has convinced me that green sand can be found in many localities in New Jersey containing as much as 6 per cent potash. These beds range from a few feet to 20 ft. in thickness. They are covered with very little overburden and the material can be dug with a steam shovel just as cheaply as sand can be obtained. I estimate that 10 cents per ton will cover both the stripping and the digging of the green sand. In addition to this, there are extensive deposits of lime-sand or marl adjacent to the green sand beds. These latter contain about 75 to 85 per cent carbonate of lime, and about 0.5 potash. In many instances the lime-sand overlies the green sand. These deposits are also located in a region where fuel is fairly cheap, where transportation facilities are of the very best, and where labor and living conditions are good. In view of these facts, it seems to be much more probable that potash can be produced directly from green sand at a profit rather than from feldspar.

Alunite has been largely exploited as a source of potash and is being used for that purpose now. It is, however, found as yet only in Utah. This deposit is comparatively small and is largely under control of a few people. It seems hardly probable, in view of the slow progress which has been made to date, that this will ever be the source of anything more than a local potash industry.

This applies to most of the other silicates, such as leucite and cerisite, all of which can be treated along the lines of attack proposed for feldspar and glauconite.

Considerable experimental work, some of it on a large scale, has been done on those processes in which lime and a chloride are mixed with feldspar or green sand and the mixture ground, furnaceed, leached, and the resulting liquor evaporated. Mr. W. H. Ross of the Bureau of Soils published a very interesting paper along this line in 1912, giving the results which he was able to obtain by heating together a mixture of feldspar, limestone and either calcium chloride or salt. He found that unless he used quite a large proportion of lime and chloride that his yields were low. His best results being obtained on a mixture of one part feldspar, three parts limestone and one-half part calcium chloride, under which condition he obtained a yield of almost 95 per cent. But with a mixture of one part feldspar, one part lime and one-quarter part calcium chloride, he obtained a yield of only 60 per cent. Substituting salt for calcium chloride in the latter mixture, however, he obtained a yield of 68½ per cent.

Following along practically the same lines, and using a mixture of one part feldspar, one part calcium carbonate, and one-quarter part calcium chloride, and heating this mixture in a rotary kiln 2 ft. in diameter and 20 ft. long, I obtained a yield of 55 per cent potash. By substituting salt in place of the calcium chloride a slightly better yield was obtained. As the amount of lime was decreased from the above formula less potash was obtained. The more finely the mixture was ground the better results were obtained, but the best yield I could get with feldspar, lime and salt in the proportions given above was 73 per cent when the mixture was ground to a fineness of 98 per cent passing the 100-mesh sieve and 86 per cent passing the 200-mesh sieve. This was considered about the limit of economical grinding.



Substituting sericite for feldspar I obtained practically the same yield, but with glauconite I was able to obtain a much higher yield—in fact, all investigations which I have made lead me to believe that this mineral is very much more easily attacked than feldspar. With the glauconite-lime-salt mixture referred to above we have obtained yields as high as 85 per cent of the potash theoretically possible.

This is a very easy process to carry out. The operation of crushing and grinding the material have been well developed, and the furnacing can, of course, be done in a rotary kiln. No complications are experienced in this latter operation. The required temperature is low, and either producer gas, pulverized coal or fuel oil could be used. In my experiments I used the latter fuel for convenience. I do not believe any complication would arise from the use, however, of pulverized coal, and certainly not from producer gas. The material furnaces easily at temperatures varying from 800 to 1000 deg. C., depending on the composition of the mixture. No fusion takes place, the effort being made to produce a soft, porous clinker. This leaches easily without grinding, and 95 per cent of the soluble potash in it can be extracted with water. The amount of fuel required in the kiln is much lower than that required for the manufacture of cement, and certainly should not exceed for the dry process 250 lb. to the ton, and for the wet process 350 lb. to the ton. Any loss by volatilization can be taken care of by Cottrell treaters.

By leaching in series very strong solutions can be obtained so that the amount of water to be evaporated is cut down to a minimum. Potassium chloride can be easily separated from either calcium chloride or sodium chloride, and the latter can be returned to the kilns with the next charge.

On the other hand, if the sulphates are used, a difficult separation nearly always results. While there is probably less volatilization with the sulphates, there is much more difficulty experienced in obtaining a pure potash salt and, as it is well known, the chloride is the most acceptable salt for fertilizer manufacture.

Strange to say, very few attempts have been made to produce potash commercially by this process—possibly because it has not promised anything like the returns offered by some of those other processes in which by-products are obtained.

The Atlantic Potash Company recently bought out the plant of the old Northampton Cement Company at Stockertown, Pa., which had been standing idle for some time. They are operating under the patents granted to George F. von Kolintz (No. 1,201,396). This process consists in oxidizing the green sand and heating the same with calcium chloride without the use of lime. This plant is now in operation, and we understand that some potash has been produced.

Another method of liberating potash is covered by patents to S. Peacock, and consists in heating the finely ground mineral with lime under pressure in an autoclave, whereby the potash is made soluble and is leached out. The Waverly Chemical Company, Camden, N. J., has operated under Dr. Peacock's supervision, using green sand. They made some potassium carbonate which was sold to glass makers, but their operations have now been discontinued, presumably because they could not be conducted at a profit.

The Kaolin Products Company, Jones Point, N. Y., is

using this same process in a small way, employing feldspar. They make a species of sand-lime brick from the residue. This brick, I am informed, is a very superior article.

Furman Thompson proposed to employ acid sulphate of soda and salt to attack feldspar (U. S. patent No. 995,105, and also No. 1,091,034, to H. P. Basset). Muriatic acid and salt cake are obtained as by-products. The Spar Chemical Company, Baltimore, Md., built a plant at Curtis Bay, Md., prior to the war, to produce potash by this method, but their efforts here failed, due largely to the difficulty of separating the sulphate of soda and potash.

Along the second line of patents referred to above (in which the potash is volatilized), we have the three granted to H. G. Brown, and covering the manufacture of potash and slag cement from feldspar. Brown proposes to fuse together limestone, feldspar and calcium chloride in a metallurgical furnace heated with coke. The potassium chloride is given off as a fume, which is to be collected by a Cottrell treater. The slag, which is tapped off, is to be mixed with slaked lime and ground into slag cement. The Buffalo Potash & Cement Corporation will operate this process. They have purchased the plant of the Niagara Cement Company in Buffalo, and expect soon to be ready to operate.

We also note in recent literature the organization of the Canadian Potash Corporation, which proposes to manufacture potash and cement along somewhat similar lines. They have purchased a crushing plant at Gravenhurst, Ont., where there is said to be a large feldspar deposit, and also a cement plant at Durham, Ont.

While we are disposed to criticise the cement end of these propositions so far as they anticipate making slag cement, the potash end looks entirely feasible, and if it can be operated independently of the slag cement production, it may be developed to any extent desired. Slag cement at the present time is not a very salable product, and we believe that practically all of those who first undertook its manufacture in this country have now abandoned it.

We now come to a series of patents most of which are dependent on some valuable by-product for their success with normal markets. For instance, we have the patent of Hart, in which barium carbonate, carbon and feldspar are heated together, and barium sulphate or other barium salts are obtained as by-products. The application of this patent is, of course, limited to the market for barium compounds. There are also a large number of patents in which aluminum salts are obtained as by-products. As there is about twice as much alumina as potash in feldspar, as ordinarily mixed, there would, of course, be a very large tonnage of alum or alumina to get rid of.

For instance, feldspar may average 20 per cent alumina and 10 per cent potash; therefore, for every ton of potassium chloride produced there would be possible  $4\frac{1}{4}$  tons of dried aluminum sulphate, or  $8\frac{1}{4}$  tons of dried alum. The amount of potash used in this country far exceeds the alum. If we consider the aluminum in feldspar on the basis of bauxite—the raw material for aluminum as well as alum, and of which the domestic production is about 225,000 tons annually—we can arrive at a better estimate as to the limitations of this field. Bauxite averages about 57 per cent

alumina, then the above amount is equivalent to 128,250 tons of alumina, which would take care of about 102,000 tons of potassium chloride or approximately 64,000 tons of potash.

I am informed that one experimenter is making brick of the residue from his leachings. This, of course, like the cement field, opens up a large market for the so-called by-product, especially since the brick is said to be of the highest quality.

In many of the processes proposed the quantity of potash is very negligible compared with that of the by-product, and under normal conditions its value is generally much less, so that with most of them potash is really the by-product and the other constituent the main one.

Summing up the situation, I believe that the largest future source of cheap potash available in this country is in the iron industry and the cement industry. Germany is reported to have \$150 invested in her potash mines and equipment for every ton of potash produced annually. On this basis \$37,000,000 would be needed to produce the 250,000 tons of potash imported into this country.

I believe that the expenditure of this amount of money in this country in these two industries alone would result in the recovery of potash now lost amounting to nearly 200,000 tons.

The balance could easily be obtained from the evaporation of lakes and brines, from beet sugar waste and from some of the processes now proposed for the manufacture of potash direct from feldspar or glauconite.

What is needed in this country to develop a potash industry is not research alone, but the feeling that when this industry is built up proper legislation will be enacted to prevent its being tumbled down by cut-throat methods from the foreign producer. While this might result in slightly higher-priced potash to the farmer, I fully believe that he will be justified in paying the higher price in order to be free from foreign dictation.

Baltimore,  
Maryland.

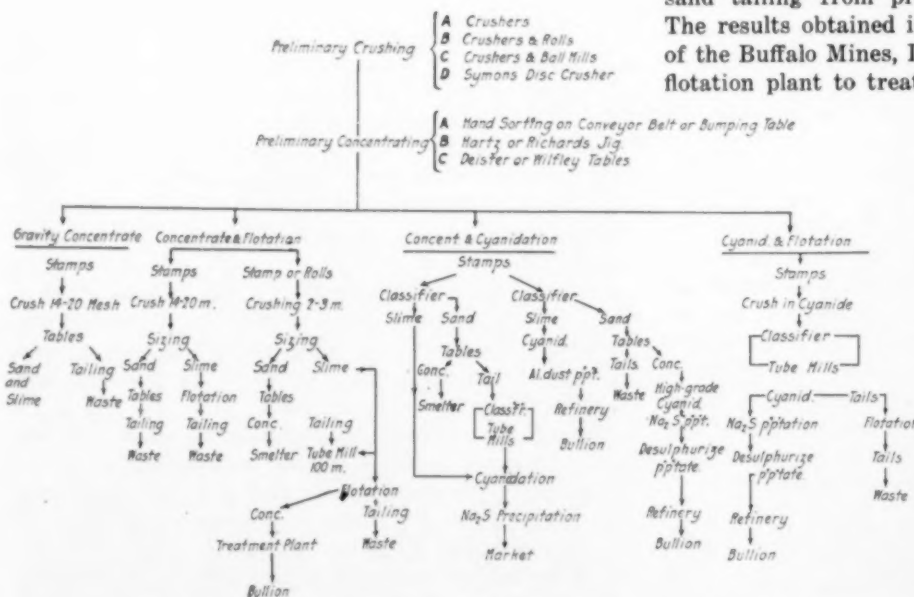


FIG. 1—MILLING PRACTICE COMPARISON IN COBALT DISTRICT.

## Synopsis of Recent Metallurgical and Chemical Literature

### Flotation

**Present Flotation Practice on Cobalt Ores.**—In the June, 1917, bulletin of the Canadian Mining Institute, pp. 544 to 553, is an article of considerable interest by J. M. CALLOW and E. B. THORNHILL on flotation as practised on cobalt ores. Flotation on a comparative commercial scale was first tried out by an experimental

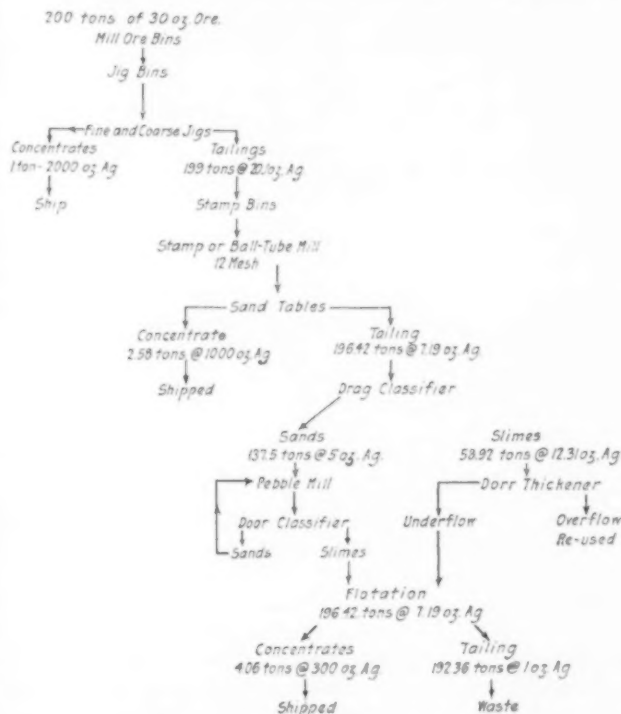


FIG. 2—COMPLETE MILL FLOW SHEET.

plant built and operated by the Buffalo Mines, Limited. This plant consisted of a two-compartment standard length Callow rougher cell and one one-half size Callow cleaner cell. The plant was built to determine the feasibility of concentrating the silver values in the stacked sand tailing from previous concentrating operations. The results obtained in this plant led the management of the Buffalo Mines, Limited, to erect a 600-ton Callow flotation plant to treat these tailings. This plant was

put in operation in September, 1916. The McKinley-Darragh-Savage Mines soon followed with a second plant, of 200 tons daily capacity, and at the present time the Nipissing Mines, the Coniagas Mines, the Dominion Reduction Co., the Northern Customs Concentrators, and the National Mine, use the Callow pneumatic system of flotation.

Fig. 1 shows the milling practice at the different mills in Cobalt district at the present time. The flotation process has not replaced the standard method of gravity concentration, but its particular function is to save

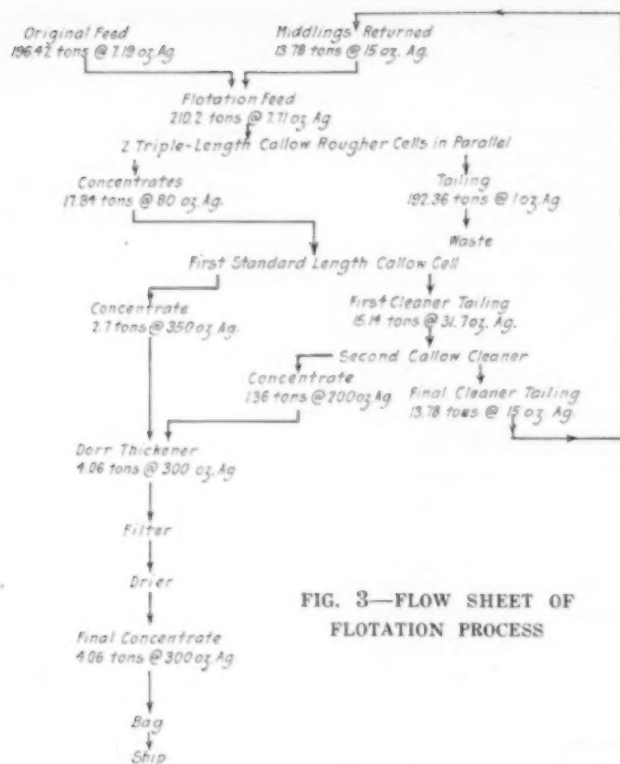


FIG. 3—FLOW SHEET OF FLOTATION PROCESS

the more friable silver minerals and fine leaf silver escaping from the gravity concentration. Fig. 2 shows the disposition of the flotation plant, and Fig. 3 indicates the treatment of the ore in the flotation plant proper.

The ore must be comparatively fine ground to liberate the contained values. The economic limit of grinding appears to be reached when not more than 1 per cent to 2 per cent is retained on a 100-mesh screen. Practically all the plants use mixtures of pine oil, coal-tar creosote, and coal tar; 15 per cent pine oil, 75 per cent coal-tar creosote, and 10 per cent coal tar gives an efficient mixture. At times, a mixture of 10 per cent pine oil and 90 per cent sulphur fuel oils gives satisfactory results.

The recovery of values by means of flotation varies over a wide range depending mainly on the product going to flotation, the grade of concentrate required and the experience of the operator. The most important item is the last one mentioned as it requires considerable time to produce an efficient operator. The average efficiency in flotation at the McKinley-Darragh-Savage Mines, Limited, is 82 per cent. The average headings at this mill runs 6.37 oz. and the tailing 1.14 oz. of silver.

With the exception of the Buffalo Mines, Limited, the companies producing flotation concentrates depend on the smelters in the United States for the disposal of their products and the schedules offered are not especially attractive. A representative schedule stipulates a \$12 to \$14 treatment charge per ton and payment on New York quotation of 95 per cent of the silver content. With silver selling at 70 cents an ounce the marketing cost per ton on a 300-ounce concentrate would be as follows:

Silver loss 5 per cent (15 ounces at \$0.70).....	\$10.50
Treatment .....	14.00
Freight .....	11.32
Representation at the smelter.....	.50
Bagging and miscellaneous.....	2.00
Total marketing value for one ton of concentrates.....	\$38.32

This high marketing charge has led to much investigation on part of the companies to devise suitable means for treating their concentrates locally. Cyanidation, desulphurization followed by cyanidation and oxidizing roasting followed by cyanidation of the roasted product gave no promises of economical results. A chloridizing roast followed by leaching, either with cyanide or an acid-brine solution has given the most satisfactory results. The Buffalo Mines is now treating 5 to 6 tons of flotation concentrates daily by this method, and claim a 95 per cent to 98 per cent extraction of the silver values. At this mill the chloridized product is first leached with an acid-leach to extract the base metals and then by a cyanide leach to recover the silver chloride.

Flotation has been adopted very rapidly throughout the district and to date only 790 tons per day of current tailings are not being treated by flotation. There are approximately 2,500,000 tons of impounded tailing in the district averaging 4 to 6 ounces of silver per ton that can be recovered by flotation at a substantial profit. As the ores of the district become lower in value flotation will of necessity become increasingly more important due to the cheapness of the process.

#### Gold and Silver

**Flotation Tests on a Transvaal Gold Ore.** F. WARTENWEILER, in the Journal of the Chemical, Metallurgical and Mining Society of South Africa, November, 1916, pp. 87 to 90, gives a very interesting comparison of different treatments of a gold ore from the Transvaal. The best extraction was obtained by flotation.

The ore treated was an arsenopyritic gold ore. Grinding this ore to 150 mesh and cyaniding gave a maximum extraction of 45 per cent. By preliminary treatment of the ore with sodium carbonate or sodium hydrate, this recovery may be increased from 3 to 5 per cent. Recovery by amalgamation was so low as to be negligible. Sweet roasting followed by cyaniding gave the following results: The ore was crushed through 20 mesh, and contained 14 dwt. of gold. After roasting, the ore contained 95 per cent of the original gold, the loss being due to volatilization. The gold content of the ore ready for cyanidation was 13.75 dwt., of which 11.95 dwt. were extracted. The balance of gold was in the residue left after treatment with cyanide. The extraction amounted to 86.9 per cent. The net extraction, therefore, amounted to 86.9 per cent of 95 per cent, or 82.5 per cent. The low extraction, combined with high operating costs due to local conditions, would make the roasting operation prohibitive. Trials with gravity concentration and cyanidation gave a total extraction of 70 per cent.

Flotation tests with various oils, and in neutral, alkaline and acid circuits, were carried on, using 500-gm. samples. The coarse sulphide, which was only a small amount of the total, was recovered by panning, and added to the flotation concentrates.

The ore was ground in water to 90 mesh. It was kept submerged so as to prevent serious oxidation. It was pulped in water in a ratio of 5 to 1 with wood creosote and paraffine oil. Lime in solution was added until the alkalinity was 0.005 per cent CaO. The froth produced during the operation was withdrawn continually. After 15 minutes the dark, persistent froth of fine mineral floccules gradually changed to a froth of lighter



color, showing that gangue was being floated. At this stage the machine was stopped and the tailings discharged, in order to study the products. In general, the skimming of the froth was continued until no more mineral matter could be observed. This procedure naturally contaminated the concentrates, necessitating a further cleaning of the product, which was done by passing the initial concentrates through the machine a second time. The products of the second treatment were concentrates and middlings; in practice, the latter would usually be returned to the head of the roughing machine.

The following table will prove of interest, and needs no further explanation:

Product	Per Cent Weight	Assay, Dwt. per Ton	Value per Ton Original Ore, Dwt.	Per Cent of Total Gold Value
Concentrate..	14.7	67.0	9.85	71.1
Middling ....	12.5	8.7	1.09	7.9
Tail .....	72.8	4.0	2.91	21.0
	100.0		13.85	100.0

The middlings and tailings were treated by direct cyanidation with air agitation. The concentrate was roasted, then amalgamated and cyanided, the results obtained being illustrated in the following table:

Product and Assay	Treatment	Assay of Residue, Dwt.	Extraction, Per Cent	Extraction of Total Value of Ore
Roasted concentrate 89.2 dwt. ....	Amalgamation and Cyaniding	6.9	91.3	65.0
Middling, 8.7 dwt. ....	Cyaniding	1.7	80.4	6.4
Tail, 4.0 dwt. ....	Cyaniding	1.0	75.0	15.7
Total .....				87.1

The calculated value of the total residue was 1.78 dwt.

As earlier results with raw sulphide ore gave negative results with cyanidation, the concentrated material was not treated in the raw state. There was practically no premature precipitation of gold by residual carbon from flotation oil ignited during roasting. This matter was determined by treatment of the cyanide residue with sodium sulphide.

The most striking feature of the tests made is the comparative ease with which the gold is dissolved from the middlings and tailings. This emphasizes the extent to which the refractory material is transferred to the concentrates. In practice, it is advisable to assume a 5 per cent loss of gold, due to volatilization during roasting. This loss is 5 per cent of 71.1 per cent, or 3.55 per cent of the original ore. The total extraction is, therefore, 87.1 per cent of 96.45 per cent, or 84.05 per cent.

### Copper, Lead and Zinc

**Ore Treatment at the Falcon Mine, Rhodesia, South Africa.** An article in the *South African Mining Journal*, Dec. 30, 1916, p. 421, by H. R. ADAM, gives a lengthy description of the metallurgical practice at this mine, which is situated at Umvuma, about 160 miles from Bulawayo. The most convenient method of illustrating the practice is by means of flow sheets, but before passing to these it may prove of interest to know that this mine has operated for the past two years, the monthly output being approximately 600,000 lb. of copper, 3000 oz. of gold, and 6000 oz. of silver; 18,000 to 20,000 tons of ore are treated per month, of which 14,000 to 15,000 tons are sulphides and the rest oxides. The sulphide ores contain 2.5 per cent copper as chalcopyrite and 5

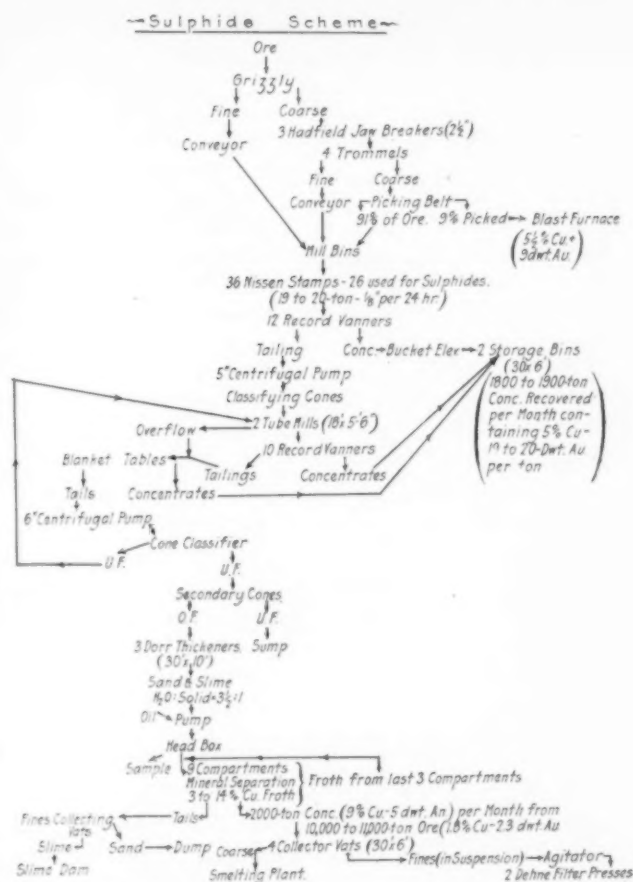


FIG. 4—FLOW SHEET OF MILL OPERATING ON SULPHIDES,  
FALCON MINE, RHODESIA, SOUTH AFRICA

to 6 dwt. of gold per ton. The chalcopryrite is associated with iron pyrite and pyrrhotite. The oxidized ore runs 0.3 per cent copper and 4 dwt. gold per ton.

Figs. 4, 5 and 6 illustrate the various operations at the mill and at the smelter, and require no further explanation:

It is of further interest to know that the mill concentration plant recovers 60 per cent of the gold and 20 per cent of the copper, while the flotation plant recovers 20 per cent of the gold and 70 per cent of the

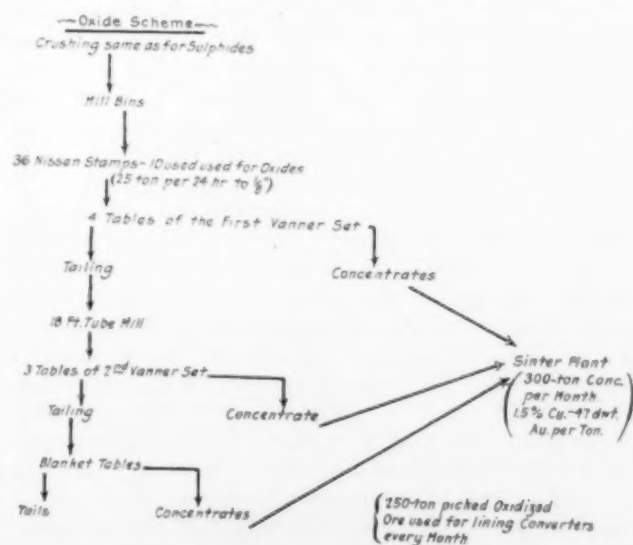


FIG. 5—FLOW SHEET OF MILL OPERATING ON OXIDES,  
FALCON MINE, RHODESIA, SOUTH AFRICA



FIG. 6—FLOW SHEET OF COPPER SMELTER, FALCON MINE, RHODESIA, SOUTH AFRICA

copper. This gives a total extraction of 80 per cent of the gold and 90 per cent of the copper. Also it might be especially noted that little or no flotation concentrates are sintered, but are directly delivered to the blast furnaces.

## Recent Metallurgical and Chemical Patents

### Caustic Soda

**Purification of Caustic Soda.**—A process for the electrolytic purification of caustic soda is patented by HERMAN B. KIPPER of Solvay, N. Y. The process is applicable to the different processes for the manufacture of caustic soda, such as the lime-soda and the electrolytic process. In these processes the dilute caustic first produced is evaporated in vacuum pans and later in open evaporating vessels. During the process of causticization and of evaporation in the vacuum pans and in the open or cast-iron pots, small amounts of metals are dissolved, which must subsequently be gotten rid of as far as possible. These have usually been removed by settling, the soda being heated up to 500 deg. C. in the cast-iron pots and allowed to cool gradually. According to the present patent, the caustic liquor from the vacuum pans is electrolyzed with nickel anodes with low voltages and a current density of 50 to 150 milliamperes per square inch. One form of apparatus which can be used is shown in Fig. 1, in which 10 designates the purification vessel for the fused caustic soda, it being shown in the form of an open-topped pot which may be composed of iron, the pot being set in a firebox, 11, whereby heat may be applied to raise the temperature of the caustic liquor to the appropriate point. In order to prevent metal from the sides of the pot from entering the caustic liquor, a diaphragm or lining, 12, of fine wire gauze or semi-permeable structure is arranged within the pot and is supported from the inner

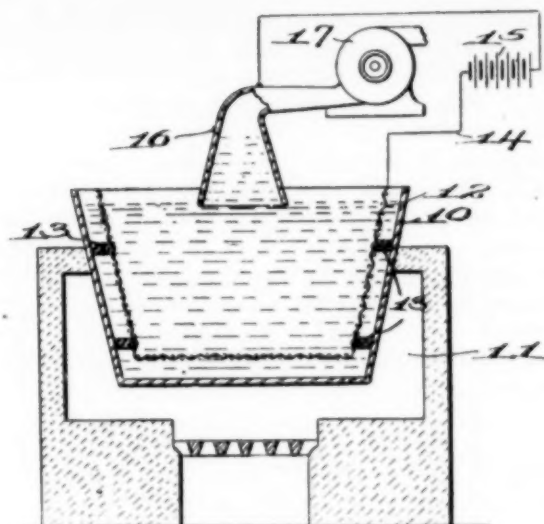


FIG. 1—CAUSTIC SODA PURIFICATION APPARATUS

wall by insulators, 13, the space between the semi-permeable diaphragm or lining and the wall of the pot being filled with powdered limestone. The semi-permeable diaphragm or lining is preferably composed of nickel gauze, and it is insulated from the pot, 10, and is connected by the wire, 14, to one pole of the battery or source of electric current supply, 15. The anode in this construction is in the form of a cone, 16, composed preferably of sheet nickel, the bottom or larger end of the cone being immersed slightly below the level of the caustic liquor in the pot, and the upper end of the conical anode is connected to a vacuum or exhaust pump, 17, which in the operation of the apparatus serves to maintain a slight vacuum within the anode. In this way the caustic liquor is forced up into the anode, the greater portion of the electrical action takes place within the hollow or conical anode, and all oxygen given off in consequence thereof rises through the liquor contained in the cone and is carried off by the vacuum or exhaust pump. (1,227,453, May 22, 1917.)

### Waterproofing

**Electrolytic Waterproofing.**—Three patents have been issued to ALFRED O. TATE of Montreal, Canada, on methods and apparatus for waterproofing fibrous materials. The first patent (1,228,986) relates to a machine for waterproofing, consisting of one or more pairs of stationary electrodes of relatively great contacting surface area, located face to face with their entire surfaces in electrical contact. The positive electrode of each pair is fixed between the ends of a frame, and the negative electrode is adjustable in a parallel plane. The material may be subjected to different electrolytes by spraying on each side as it passes through the electrodes. The second patent (1,228,987) relates to a method of waterproofing consisting in treating fibrous materials with a saponaceous liquid and aluminium acetate simultaneous with the subjection of the material to the action of an electric current between electrodes, one of which is soluble. The third patent (1,228,988) relates to a machine for carrying out the above mentioned process.

The patents are assigned to the Tate Electrolytic Waterproofing Co., Inc., of New York.

## Annealing and Heat Treating of Steel and Melting of Non-Ferrous Metals in the Electric Furnace\*

By T. F. Baily

The development of electric furnaces for the heating operations subsequent to the melting and refining of steel has been attended by the usual slow process of any radically new development; and the types now in operation are the result of the gradual elimination of weak and faulty features rather than from skill in original design.

In the early development much higher prices were charged for electric current than is now the common rate, and this, in addition to the fact that central stations themselves did not consider electric furnaces commercially feasible, contributed to their slow introduction commercially. The uncertainty of fuel supply and its greatly increased cost within the last year have materially aided the introduction of electric furnaces, and the central stations have of late also taken an active interest in their introduction.

The incidental advantages of the modern electric furnace are so apparent that even at an equal operating cost for fuel electricity now has the preference, while in some cases, where the net cost of operation with electricity is less than with gas or other fuel, complete installations of magnitude are being made.

While it is not the intention to discuss in detail all of the purposes for which furnaces of the type considered in this paper are adapted, the following are some of the uses to which they have been put:

- Annealing steel castings and car axles.
- Heat treating steel castings.
- Heat treating shells.
- Carbonizing.
- Annealing aluminium, copper, or brass.
- Melting copper, brass, aluminium, or silver.

To these lines will shortly be added:

- Soaking pits for steel mills.

Rivet furnaces for structural and bridge shops. Later, when there is a serious demand for them, furnaces for heating drop forgings.

It is the purpose of this paper to deal only with furnaces actually in commercial operation.

\*A paper read before the Cleveland Engineering Society.



FIG. 1—150 KW. CAR-TYPE ANNEALING FURNACE

### GENERAL DESCRIPTION

All of the furnaces to be described later are of the so-called resistance type, and have, in the case of rectangular furnaces, two troughs made of carborundum fire sand located one on each side of the furnace, with carbon or graphite electrodes located at each end of each trough. The troughs are filled with a broken carbonaceous material called "resistor material," establishing a connection between the electrodes and completing the electric circuit. The general plan of these furnaces is similar to a closed box of fire brick in the walls of which are two glowers, which may be likened to huge incandescent-lamp filaments. The control of the current, and hence the heat, is effected by varying the voltage impressed at the electrodes, this variation being obtained by means of numerous taps on the secondary of a special transformer supplied with each furnace.

### CAR-TYPE ANNEALING FURNACES

The furnace shown in Fig. 1 is a car-type 150-kw. annealing furnace, with the capacity of heating 1000 lb. of steel to a temperature of 1650 deg. F. in one hour, and a current consumption of 300 kw. hours per ton of material heated to that temperature. The door of the furnace is a heavy casting faced with fire brick and backed by a filling of loose kieselguhr held in place by a steel plate.

The car-type furnace shown in Fig. 2 is the same in type, but of 300 kw. capacity, and is located in the same plant as the previously described furnace, and is used for annealing steel castings. The charging door is raised, showing how the fire brick car-platform forms the floor of the furnace. Furnaces of this type are well adapted for handling steel castings, and equally well for heating large or irregularly shaped forgings, or for the annealing of copper and aluminium, to which latter use they have already been put.

### CONTINUOUS PUSHER-TYPE FURNACES

When materials are of uniform size, or of such shape and nature that they can be pushed along mechanically, or placed in containers of uniform size, the continuous furnace (shown in Fig. 3) is sometimes preferable to the car-type annealing furnace (shown in Figs. 1 and 2).

Fig. 3 shows a 120-kw. furnace carbonizing rifle receivers in one of the large rifle-making plants in the East. The parts to be carbonized are placed in the

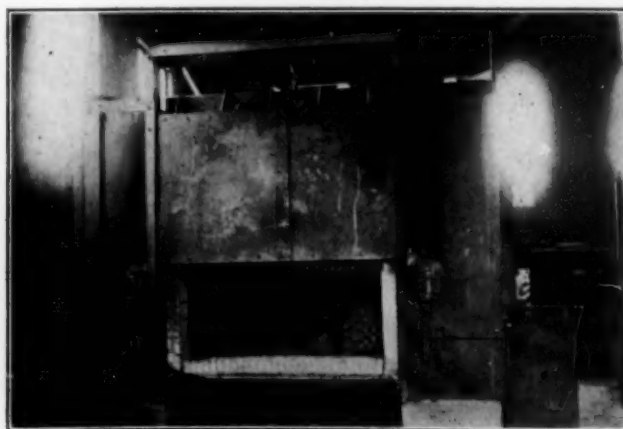


FIG. 2—300 KW. CAR-TYPE ANNEALING FURNACE



usual pots and are pushed through the furnace by means of the pushers, as shown.

Other furnaces of the same general type, but with a different type of pusher, are used for annealing brass and German silver flatware blanks in one of the oldest and best known plants making plated tableware. Two of these 200-kw. units in operation at this plant have an hourly capacity of 1 ton of brass each.

#### AUTOMATIC HEAT TREATING FURNACES

The heat treatment of steel, as distinguished from the simple annealing operation, consists of heating the metal to above a critical point, quenching at that temperature in some cooling medium, such as water or oil, and subsequently reheating to a temperature under the critical point mentioned.

As materials with specified heat treatment are usually placed in locations where they are to be subjected to considerable strain, more attention has been given to so-called heat-treating operation than to the usual annealing, although both annealing and heat treating are equally important, if dependence is to be placed on the effect that is expected.

For the highest quality of work in heat treating, two furnaces are recommended, each one running with the ruling temperature desired in the material at that particular stage of its treatment, and a quenching bath (or spray, as the case may be) located between the discharge end of the first or heating furnace and the charging end of the second or drawing furnace.

The material is gradually moved forward by a pusher (such as is shown in Fig. 3), removed by manipulators, and quenched in a tank. It is later removed and placed in front of the drawing furnace (as shown in Fig. 3), and later, after having passed through the drawing furnace, discharged and cooled in a specified manner. These particular furnaces, of which there are two sets of two furnaces each already installed in one of our progressive manufacturing plants, are used in the heat treatment of cast-steel drawbar knuckles. Each set has a capacity of 72 tons of steel per day and consumes 900 kw. per set.

These particular furnaces, and a similar set of 600-kw. furnaces for heat treating large high-explosive shells, are automatically controlled by special pyrometers, so that the only hand work required is the

placing of material on the charging platform of the first furnace of the set.

Equipment of this type, while expensive in first cost, approaches very closely the highest point of commercial efficiency, as they not only leave no operation to chance but reduce the labor items to a minimum. I believe that it may be said of one of these units that hundreds of thousands of pieces have passed through it without a greater variation in temperature than 10 deg. from the stipulated point.

This type of equipment is adaptable where the material to be heated is of uniform section, or can be placed in suitable metal containers, and where extreme accuracy and minimum labor cost are desired. With such an installation it is possible to produce a uniformity in the product in the plant in line with the tests of the laboratory.

#### MELTING FURNACES FOR BRASS

The reliability of the type of furnaces described above for annealing and heat-treating work seemed to justify the assumption that with the necessary modifications as to hearth and shape of furnaces they would work equally well on non-ferrous metals. The first furnace for this purpose was installed three years ago for melting silver in one of the plants mentioned previously, where continuous annealing furnaces are used for annealing brass flatware blanks. This furnace was rectangular in shape and provided with a hole in the top and the necessary cover. The metal is melted in crucibles, the furnace being adapted to hold two crucibles of size No. 40. Not only is silver melted, but



FIG. 3—120KW. CONTINUOUS PUSHER TYPE HEAT TREATING OR CARBONIZING FURNACE

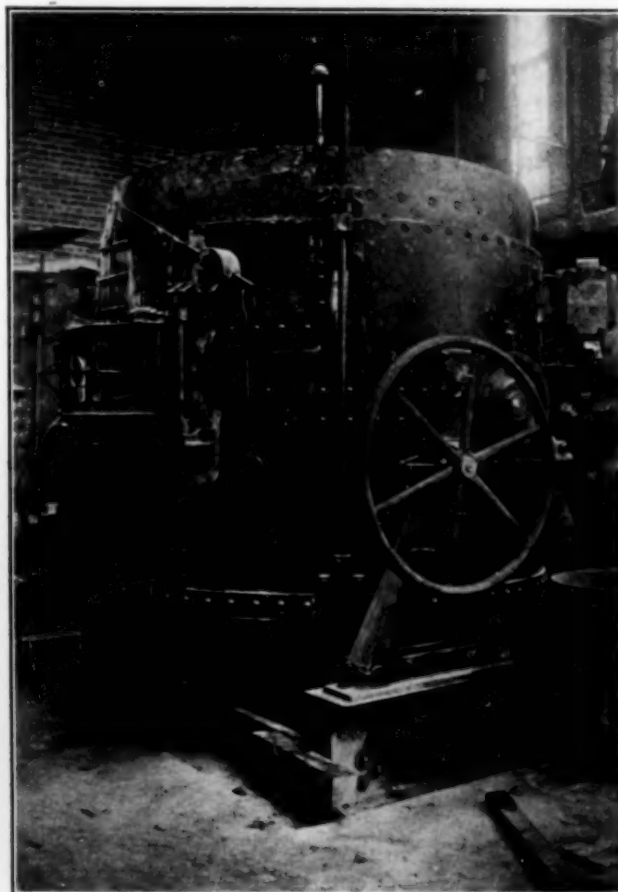


FIG. 4—105 KW. TILTING-HEARTH MELTING FURNACE

scrap copper as well. The ruling temperature of the furnace is 2500 deg. F., very hot metal being required, as the castings are small and the molds are heavy iron chills.

There seems to be no real necessity for the use of a crucible excepting in the melting of precious metals. Their high cost, rapid destruction, and the necessity of handling small quantities of metal when they are used, with attending high labor charge, has led to the adoption of the tilting-hearth furnace shown in Fig. 4. This type of furnace was first used for aluminium and aluminium alloys, and later the same type, with slight modifications in the details, has been used to melt brass.

This furnace, with a normal rating of 105 kw., and a melting capacity of 600 lb. per hour, has melted, and superheated to a suitable pouring temperature, the following materials, with an average current consumption as noted below:

New Red Brass—400-lb. heats in 1 hr. with 90 kwh. or 450 kwh. per ton.
Scrap Yellow Brass—(72 per cent Cu. 28 per cent zinc) 750-lb. heats in 1 hr. 10 min. with 120 kwh. or 320 kwh. per ton.
Scrap Yellow Brass—(70 per cent Cu. 30 per cent zinc) 800-lb. heats in 1 hr. 18 min. with 110 kwh. or 275 kwh. per ton.
Brass Chips and Borings—(70 per cent Cu. 30 per cent zinc) 700-lb. heats in 2 hr. 30 min. with 220 kwh. or 720 kwh. per ton.

Much lower current consumptions have been made on individual heats, but the above are the averages of several heats of each metal.

Of all the electric furnaces of the type described now developed, the tilting-type furnace is the one offering the greatest saving in cost over fuel-fired furnaces of any type, whether oil, gas, or coke fired, since the metal loss is lower, the crucible cost is eliminated entirely, while the labor item is less on account of size and convenience of operation.

The following figures may be safely taken as operating conditions with yellow brass in a shop operating 24 hours per day:

Electricity, 400 kw.-hr. per ton at 1 c. ....	\$4.00 per ton
Metal loss, 1 per cent zinc at 10c. per lb. ....	2.00 per ton
Labor, 1 man per hour per 600 lb., at 40c. per hour. .	1.20 per ton
Renewals and repairs .....	1.00 per ton
Total per ton of melt.....	\$8.20

It is believed that the performance of these brass-melting furnaces is such, and the saving over other methods so great, that their introduction will be rapid, even much more so than the annealing and heat-treating furnaces described, which are now accepted without question.

Electric furnaces are not a cure-all for the troubles in the metal industry. They are, however, a much more accurate and precise tool than fuel-fired furnaces, and are the means of eliminating many of the troubles in metal production and manipulation, and will, in the lines for which they are adapted soon come into as general use for heating as electric motors have for power.

The Electric Furnace Co. of America,  
Alliance, Ohio.

### Porcelain Pyrometer Tubes

For the purpose of protecting thermo-couples at furnace temperatures the tubes made of Marquardt refractory porcelain by the Royal Berlin Porcelain Manufactory have proven very successful, as is shown by the experience of many years. These protection tubes, owing to war conditions, are now not obtainable.

The need of effective protection for the costly platinum and its alloys so extensively used in pyrometry prompted investigation and manufacture in this country. The Ceramic Section of the National Bureau of Standards carried on experiments for the purpose of reproducing, and if possible of improving upon the Marquardt porcelain. The result was a highly refractory product which, though made entirely from American raw materials, was found to be of most excellent quality. The manufacture of this porcelain was taken up by the Stupakoff Laboratories of Pittsburgh, Pa., who successfully overcame the unavoidably attending difficulties, and brought on the market a protection tube under the name "Usalite."

It is claimed by the manufacturers that tubes of this material will readily withstand exposure to temperatures exceeding 1650 deg. C. A highly refractory glaze covers the surface of the outer pyrometer tubes in order to make them impervious to gases of combustion. In strength tests, 5/16 inch unglazed inner tubes; on supports placed 5 inches apart, broke under a centrally applied load of 20 pounds. Outer tubes of standard size 11/16 inch diameter, submitted to the same test broke at 212 pounds.

An 18-in. outer tube, freely suspended at its upper end, broke under impact test by applying a 50 pound weight to its lower end when swinging from an angle of 90 deg. Exposed to a temperature of 1370 deg. C., standard outer Usalite tubes in a horizontal position and unsupported for 6 inches did not bend during six weeks' continuous service.

Usalite tubes, when withdrawn from white hot furnaces and brought into the open air neither broke nor cracked. The smaller diameter unglazed tubes effectively withstood sudden exposure to the highest temperature. A glazed outer tube heated to 1100 deg. C. readily withstood the introduction of cold steel rod of nearly the same diameter as that of the bore of the tube.

Rare metal thermo-couples and resistance thermometers, which are made of platinum and platinum alloys, require considerable protection. These metals, when heated, absorb large quantities of gases and metallic vapors, and when in this state they also readily combine with phosphates and silicates, all of which contribute to causing physical changes and making them unfit for their intended use. For these reasons the insulating tubes, containing the active portions of the pyrometers, are slipped into other (outer) protection tubes with closed ends. These tubes, besides possessing all the properties required of the inner tubes, must remain impermeable to gases at high temperatures.

Impermeability is imparted to porcelains by glazing their surface. The best of such glazes begin to soften at about 1400 deg. C. (about 2550 deg. Fahr), whereafter imperviousness rapidly diminishes. Pure silica and the silica glazes of porcelain tubes at high temperatures devitrify in a reducing atmosphere and combine with alkaline substances. It is therefore recommended to enclose, whenever possible, the outer pyrometer tubes in others which combine mechanical strength with refractoriness and density of structure. These shields, which are commonly known as pyrometer tips, serve as an effective protection for the fragile pyrometer tubes against breakage through mechanical injury and sudden changes of temperatures, beside, serving as effective filters of furnace gases and vapors.



## Fundamental Hue Scale for Scientific Color Designation

Dye manufacturers and those who deal in or have much to do with various kinds of dyes will without doubt gladly welcome anything that will tend to increase the accuracy of color designation and nomenclature. They will, therefore, be interested in an extensive series of experiments recently carried on in the Research Laboratory of the Eastman Kodak Company for the purpose of obtaining a fundamental color scale.

There are two ways of analyzing and specifying color, one being the trichromatic method of analysis in terms of the three primary component colors, red, green and blue, and the other the monochromatic method of analysis in terms of the wavelength of the dominant hue or its complementary hue and the per cent white (purity or saturation). The fundamental color scale as determined in the Kodak Research Laboratory is based on the monochromatic method of analysis, and it is the purpose of this article to show how important this method is to any one interested in reliable color nomenclature and describe the method of determining the unit for the color scale.

When light rays from the sun or other luminous object or substance impinge upon the retina of a normal eye, sensations of light are produced, and in such sensations two factors may be distinguished, one being a factor of brightness and the other of color. The sensation of brightness is dependent upon the intensity of the light and that of color upon what may be termed the "quality" of light radiation. Light energy is transmitted in the form of waves of varying wavelength, and the quality of the light radiation, which the eye perceives as color, is dependent upon the length of the waves.

Pure color is produced by homogeneous light—that is, light of equal wavelengths. Usually, however, colored light is made up of a number of different kinds of wavelengths, and the eye cannot recognize the individual component wavelengths, but averages the mixed radiation as a single stimulus which produces a single color sensation. When a color is produced by light of one wavelength which exactly matches the single-color sensation of mixed radiation, the color is called the dominant hue of the mixture. Moreover, the extent to which the light consists of wavelengths of different color varying about that of the dominant hue as an average is called the "saturation" or "purity" of the color, a pure hue being produced by waves of only one length, while less saturated colors consist of waves of varying length. Light such as that coming from the sun, for instance, consists of a variety of wavelengths, the combination of which causes a sensation of white light to be produced. Sunlight can be broken up into its various components by means of a glass prism or diffraction grating, thus providing the various colors of the spectrum.

The sun, of course, is our greatest source of light, and spectral colors obtained from noonday sunlight are accordingly by far the best colors to take as standards in the preparation of a fundamental color scale. The number of gradations of color, or hues as it is more proper to call them, perceptible to the eye in the spectrum depends upon the experience of the observer and the apparatus used, varying from the six so-called

dominant hues (red, orange, yellow, green, blue and violet) to 128 distinct hues distinguished by careful observation with the special apparatus used for this purpose.

It can be demonstrated experimentally that with the exception of the purples, any color can be matched by adding white light in the proper proportions to spectral light of some definite hue (monochromatic or pure single-color light), and the saturation or purity of the color is indicated by the extent to which the color departs from the condition of monochromatism. In this way a direct measurement of fundamental properties of a color can be made, the hue being specified by the wavelengths of the monochromatic light used (wavelengths of the dominant hue) and the purity or saturation by the ratio of the intensity of the white light to that of the monochromatic light (per cent white).

In the case of the purples for which there are no spectral colors to represent their hues, some mixture of the color with monochromatic light can be made by which the sensation of white will be produced, the terms of the color specification then being the wavelength of the complementary dominant hue (the hue which when mixed in the proper proportions with the color to be matched produces white) and the per cent of monochromatic light in the mixture (per cent hue).

Now it seems to be apparent that, since wavelengths of radiation is used to express hue, if a hue scale is to be established, the points on the scale should be designated in wavelength units. It has been found, however, that equal wavelength differences do not produce equal color sensation differences throughout the sensation scale under consideration. Hence, the wavelength unit is not suitable for use as a unit in the establishment of a scale of subjective color sensation, since the first requirement of a scale for the measurement of any quantity is that the unit used shall be of a fixed magnitude and of the same value throughout the scale.

The only alternative is to adopt the least perceptible color sensation difference as a unit and assume that this sensation unit is equal at all points in the sensation scale. This unit is called a limen and is the least perceptible difference between two hues in terms of  $\mu$  (wavelength is usually given in terms of ten-thousandths of a centimeter, the unit being expressed by the Greek letter  $\mu$ ). The question as to whether such a sensation difference unit is equal at all points on any sensation scale has been discussed at great length by philosophers and psychologists; but from a purely physical standpoint, it seems entirely reasonable to make the difference limen equal at all points on a sensation scale by definition and to adopt this least perceptible difference as a sensation unit and to use it for the establishment of color sensation scales.

The problem of establishing a fundamental hue scale then, after finally getting down to the meat of the matter, is to determine for the entire range of visible radiation, going from red to violet, or vice versa, the relation existing between the wavelength unit and the least color sensation difference unit. In the solution of the problem the first step is the determination of precise values in terms of the wavelength units for the average normal eye of the least perceptible hue differences (sensation units) throughout the visible spectrum. The final values, then, must be the result of the



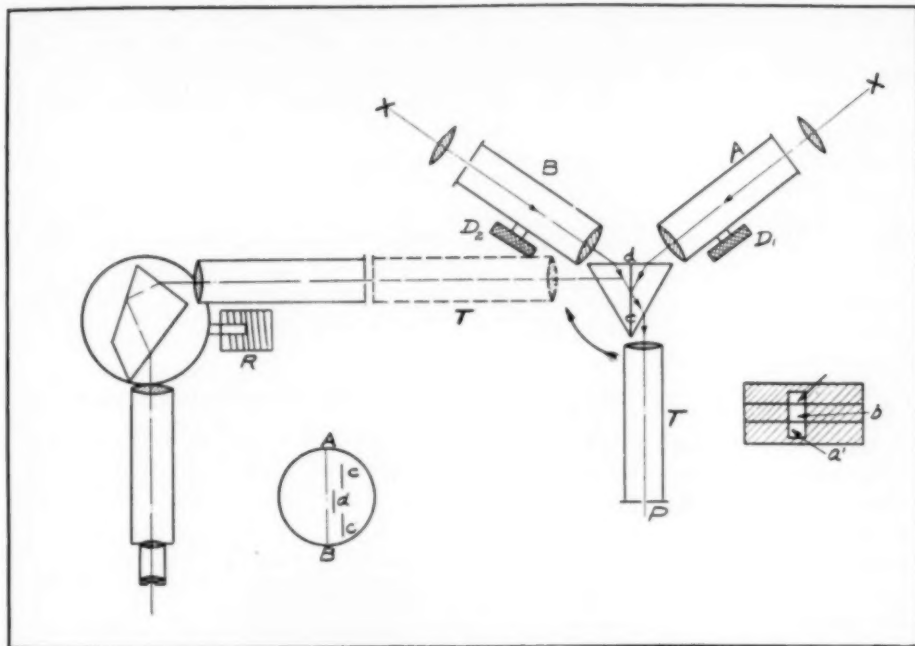


FIG. 1—ARRANGEMENT OF MEASURING APPARATUS

proper summarization of a large amount of data obtained from the study of a large number of different individuals having normal vision.

In the measurement of the difference limen highly refined apparatus is required. Considerable data were obtained in the Kodak Research Laboratory with a Brace Spectrophotometer, which was used in connection with a Hilger spectroscopie of the constant deviation type. The arrangement of this apparatus is indicated in the diagram in Fig. 1. A and B represent two collimating systems, the angular positions of which can be adjusted by means of the micrometer screws  $D_1$  and  $D_2$ . The prism consists of two 30-deg. elements cemented together along the line  $ed$ , thus forming a compound 60-deg. prism. On one of the cemented faces is a narrow silvered strip (about 8 mm. wide) which is parallel to the base of the prism and centrally placed in the vertical direction. By looking through the pinhole ocular  $P$  of the telescope  $T$  over the object glass of which is placed a diaphragm with a rectangular opening, a field as shown at the right in Fig. 1 is seen. The portions of the field  $aa'$  appear to be illuminated by monochromatic light from the

system B and the area  $b$  by light from the system A.

The entire system is mounted on a table in such a manner as to bring the telescope  $T$  into alignment with the collimating system of the Hilger spectroscopie. By looking through the eyepiece of the Hilger instrument and by bringing the lines in the field on to the cross line of the eyepiece, the wavelength of the light entering the slit, from the fields  $aa'$  and  $b$  of the spectrophotometer can be accurately measured. The field that can be seen is shown in Fig. 1.  $AB$  is the reference line of the eyepiece,  $cc'$  the lines due to the light coming from the portions  $aa'$  of the spectrophotometric field and  $d$  is the line due to that from the portion  $b$ . The

wavelength of each can be precisely measured by bringing them one after the other into coincidence with the reference line  $AB$ , reading the value directly from the calibrated wavelength drum  $R$ .

With the apparatus shown the difference in the wavelength of the light illuminating two fields, which appeared just perceptibly different in hue, was obtained. Since the desired scale is that of pure hue, fields illuminated by light as nearly monochromatic as possible must be used in such work, and it is also very important that the intensity of the light be easily controllable, for in making a judgment of equality or difference hue, it is necessary to maintain an intensity balance between the fields in order that the judgment of hue may not be influenced or confused by the existence of an intensity difference.

In Fig. 2 are shown two curves plotted from data obtained in the Kodak Research Laboratory. The abscissa or horizontal values are given in one-thousandths of  $\mu$  (designated as  $\mu\mu$ ), the violet hues being in the

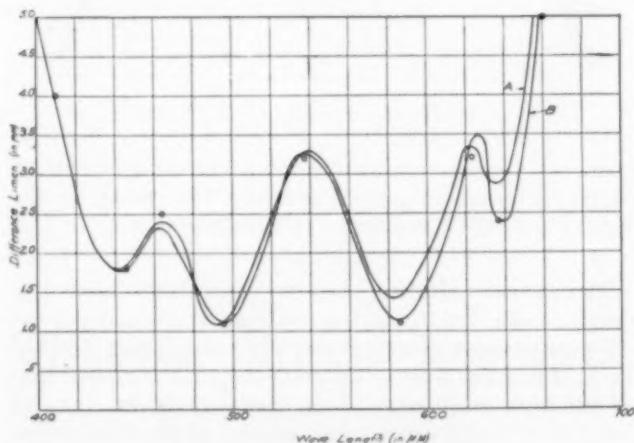


FIG. 2—TWO TEST CURVES

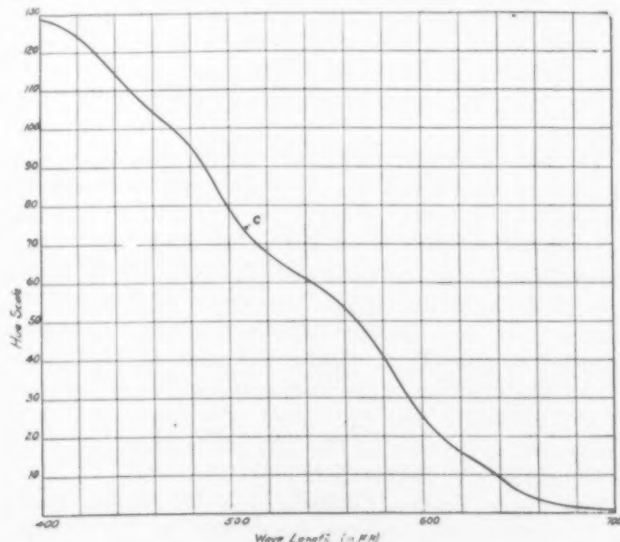


FIG. 3—HUE-SCALE READING CURVE

neighborhood of 400  $\mu\mu$ ; blue, 480  $\mu\mu$ ; green, 520  $\mu\mu$ ; yellow, 589  $\mu\mu$ ; orange, 600  $\mu\mu$ ; red, 660  $\mu\mu$ . The ordinate values are difference limen or smallest perceptible hue differences in terms of  $\mu\mu$  in various parts of the spectrum. These curves agree very well with curves plotted by other observers and they prove the statement already made, that equal wavelength differences do not produce equal color sensation differences.

In Fig. 3 is shown a hue-scale reading curve, the data being obtained by a method that involved the use of the least perceptible hue difference as the *actual unit* of measurement. Starting at a given point the entire spectrum was measured off step by step with the difference limen as the unit of length. This method gives the total number of just perceptibly different hues present in the spectrum and the distance apart of these equal sensation steps in terms of the wavelength unit. The number of distinct hues found in the Kodak Research Laboratory in a very careful set of readings was 128 between 400  $\mu\mu$  (violet) and 700  $\mu\mu$  (red). By plotting the consecutive wavelength readings as abscissae against equal ordinate increments—these readings correspond to equal sensation steps—the scale-reading curve as shown was obtained directly.

How great the value of a fundamental hue-scale with the least perceptible hue differences as a unit may be can now be readily ascertained from a close study of the scale-reading curve shown in Fig. 3. Let one imagine, for instance, that the hue-scale shown has been definitely adopted and standardized, then it is easy enough to state the position of the dominant hue on the scale and to complete the specification by giving the degree of purity or saturation of the color.

### A New Carbon Electrode Factory

Work has already been started on the first unit of a new factory that will form an immense addition to the present large plant of the Speer Carbon Company at St. Marys, Pennsylvania, and which, when entirely completed, will involve the expenditure of approximately \$500,000.00 for additional land, buildings, machinery, equipment and general improvements.

The new factory will occupy the plot of ground east of the present plant, and it is expected that a number of similar units will be erected as labor and materials are available. The company has been acquiring additional land immediately adjoining its present large holdings.

The first building, which will be devoted exclusively to the manufacture of the larger sized carbon electrodes for electric furnaces, will be 100 x 168 ft. in size and constructed entirely of brick, concrete and steel. Glass sidewalls will also be employed, thus permitting a volume of daylight throughout the entire structure. The contract for the erection of the building has been awarded to the W. L. Goeltz Company of New York City. The erection of the furnaces and the installation of the machines and equipment will consume several weeks, but it is expected that the entire plant will be in full operation by September, 1917.

The Speer Carbon Company has for several years past manufactured carbon electrodes in the smaller dimensions, the maximum sizes including 4 in. square

and 6 in. in diameter. The new factory will be equipped to turn out both round and square electrodes in all sizes from 6 to 24 in. in diameter.

The demand for carbon electrodes is daily increasing, the condition being caused by the enormous demand for tungsten steel and other products which, in turn, necessitated the installation of large numbers of electric furnaces throughout the entire country. The requirements of the Government have also influenced the Speer Carbon Company very largely in the erection of a new plant and once it is in full operation the carbon electrode shortage will be greatly lessened.

### Tripod Stand for Portable Galvanometers

The tripod stand shown in the accompanying photograph, Fig. 1, is a product of the Stupakoff Laboratories, of Pittsburgh, Pa. It was designed to do away



FIG. 1—TRIPOD FOR PORTABLE GALVANOMETERS

with the inconvenience of finding a suitable resting place for portable galvanometers. The stand is designed to fit all of the company's instruments.

**Manganese Mining Active.**—Secretary Lane recently made the following statement on manganese: "The manganese situation is most encouraging and the U. S. Geological Survey estimate for 1916 is 80,000 tons of the high grade ore. This, however, is less than 20 per cent of the present large demand of the steel industry. Production of low-grade ore is also increasing.

### Personal

Mr. L. W. Bahney has left the Sheffield Scientific School of Yale University to take a position as metallurgical engineer with the Scovill Manufacturing Co., Waterbury, Conn.

Prof. H. K. Benson, instructor in industrial chemistry at the University of Washington, Seattle, and director of the Bureau of Industrial Research, will spend his summer vacation at the plant of the American Nitrogen Products Company at La Grande, Wash., where he will conduct research work relating to the manufacture of nitrogen products from the air by use of electricity. Prof. Benson will return to his school work in the fall. He is an associate member of the U. S. Naval Advisory Board.

Mr. Arthur F. Braid has assumed the duties of metallurgical engineer in charge of metal sales for the Goldschmidt Thermit Co. of Jersey City, N. J. He succeeds DeC. Brown, who has joined the Officers' Reserve Corps at Plattsburg.

Prof. G. H. Clevenger of Leland Stanford, Jr., University was recently in New York, having just returned from the Cobalt District in Ontario, where he has been making some investigations for the Bureau of Mines.

Mr. S. C. Dickinson, formerly with the United States Bureau of Mines, assumed the duties of safety engineer with Arizona State Bureau of Mines on July 1.

Mr. B. H. Dosenbach, flotation engineer for the Butte, Superior, was in Denver on business.

Mr. S. L. Nicholson, sales manager of the Westinghouse Electric & Mfg. Co. since 1909, has been made assistant to the vice-president of the company, with headquarters at East Pittsburgh. Mr. H. D. Shute, whose election as vice-president of the W. E. & M. Co., was recently announced, will have executive charge of the company's commercial organization, both domestic and export, succeeding vice-president L. A. Osborne, whose headquarters have been transferred to New York.

Mr. Burr A. Robinson has resigned as assistant secretary of the American Institute of Mining Engineers to go into industrial work, and Prof. G. A. Roush of Lehigh University has taken up his work as managing editor of the Institute's Monthly Bulletin.

At the commencement of the Colorado School of Mines the honorary degree of E.M. was given to Walter G. Swart and H. W. Hardinge.

Mr. O. H. Wharton is the new president of the Crucible Steel Co. of America. He is a native of Easton, Pa., and was for many years general sales manager of the company, following which he was assistant to president C. C. Ramsey.

Mr. Kwong Wu, mining engineer for the Ministry of War of China, spent several weeks at Nederland, Col., inspecting the various tungsten mills of the district.

from its recent runaway condition to a state of being regulated by Government authority. The regulation of iron and steel prices, which an amendment to the food bill in the Senate places in the power of the President, is likely to remain in the bill for its final passage, and the President is likely to exercise the authority when granted, unless the manufacturers are able to devise a system under which the trade can operate to the satisfaction of all parties concerned. This may be undertaken, though the experience of the coal operators does not encourage them to undertake to do anything that will satisfy more than one or two Cabinet officers at a time. It will be recalled that the agreement of the coal operators was made with the Secretary of the Interior, who was well pleased, and as soon as the secretaries of the War and Navy departments read about it in the newspapers they hastened to "repudiate" it, though they afterwards reconsidered their dictum.

The steel market has grown narrower and narrower, as to the tonnage turnover. The mills have withdrawn more and more from the market, while buyers have become more and more averse to making engagements for far forward deliveries. The business done has been confined more and more to early deliveries, with a very few months. For such deliveries there are very few buyers and very few sellers, hence an extremely narrow market. The buying pressure has preponderated, however, and the market prices disclosed by the few transactions made have shown an almost constant advancing tendency. As the prices are, on an average, about double the prices at which the bulk of the shipments are now being made, on old contracts, they are in large manner fictitious, though strictly speaking they represent the market since there is no other market to quote.

### PIG IRON

The pig iron market is much broader than the steel market, in that there are transactions involving the delivery period for which the majority of the furnaces are in position to sell. Sales for the first half of 1918 involve a much larger tonnage than sales for the remainder of this year, and occasionally there has even been a little business done for the latter half of 1918. Prices show but little divergence for the different deliveries, though in most cases there is a difference of from \$1 to \$3 a ton. All districts except Alabama and Tennessee now show a market price of \$50 or higher f.o.b. furnace, approximately three times the price at which a great deal of iron was sold for delivery during the first half of the current year.

The pig iron market, however, has grown decidedly quieter in the past fortnight. The volume of transactions has greatly decreased, and price advances seem almost to have ceased. Indeed, there are some indications that southern iron is scarcely as firm as a fortnight ago.

### GOVERNMENT STEEL

The war requirements in steel are multiplying, but there is little concrete information as to tonnages, and nothing like a close estimate can be made as to the prospective total. It may be remarked however, that at the time war was declared estimates of war requirements ranged from 5 to 20 per cent of the output, while a month ago the more enterprising were disposed to predict 40 per cent, and at present there are many who

## CURRENT MARKET REPORTS

### The Iron and Steel Market

There is little to be said about the iron and steel market. It appears to be in the throes of a transition



believe the total requirements will exceed 50 per cent. The change in view is due to the fact that the Government finds it necessary to engage in more undertakings than was expected. If steel can be secured and fabricated there are prospects that large numbers of cars and locomotives will be bought, both for domestic use and for export, and it may be found desirable to foster the manufacture of agricultural implements and engage in other enterprises. These extra items would represent peace steel taken in change by the Government for war purposes.

#### Non-Ferrous Metal Market

*Monday, July 9.*—The markets are in a slightly easier position, with the exception of tin, which is practically unchanged. Copper has declined slightly, lead is lower in the outside market and antimony has declined considerably. The situation in spelter is unchanged. Silver remains high and firm.

*Copper.*—The Government purchased on June 29, 60,000,000 lb. of copper at 25 cents. The price, however, is understood to be tentative and subject to investigation by the Federal Trade Commission of the cost of production. The average monthly exports so far this year have been over 100,000,000 lb., or more than twice last year's amount. Since the first of July the copper market has been quiet pending Government action on copper prices. Electrolytic has declined from 32.25 on June 27 to 31.25 on July 6. Lake has remained practically stationary at 31 cents.

*Tin.*—Tin has been firm with a slightly upward tendency. Spot Straits is held at 62.00 to 62.50 cents. August delivery, 61.00, September 59.50-60, October 58.50 and November 57.50. June deliveries are estimated by the American Metal Market to be about 5000 tons. There has been a noticeable increase in the supply of tin other than Straits.

*Lead.*—The feature of the lead market has been the lower outside market. Lead sold up to 12.00 cents in this market a short time ago, but is now down to 11.25. The Trust price remains stationary at 11.00 cents.

*Spelter.*—The Government purchased 11,000 tons of high grade spelter the last week in June, for delivery over the next 10 months. The price was 13.50. This purchase did not have any noticeable effect on the market, and consumers are still holding off. The demand for spelter is very poor and the market continues dull. Prompt spelter is quoted at 9 to 9.25 cents.

*Other Metals.*—Antimony has declined from 18.75 on June 27 to 16.75 on July 6. Consumers are apparently well supplied and the good supply made an easy market. Antimony is stronger in China, owing to the disturbed conditions, but developments there have not affected the market here as yet. Aluminium is lower at 56 to 58 cents for No. 1 Virgin metal. Magnesium is \$2.00 to \$2.50 for prompt shipment. Quicksilver is \$85.00 per flask. Platinum is unchanged at \$105.00 per oz. Silver is 78 $\frac{3}{4}$ ¢. The situation in tungsten concentrates is very acute and concentrates are hard to obtain. They are quoted at \$20-\$22 per unit.

#### Chemical Market

Generally speaking, there has been little excitement in any division during the interval and prices have in the large majority of cases moved within rather narrow margins. Buying has been more or less on a rather lim-

ited scale due in part to the growing difficulty of exporting merchandise when there is a foreign market and also to the fact that in the absence of further definite advices from the government regarding those materials that are essential in the furtherance of defensive and offensive measures, buyers, and in not a few instances sellers, are withdrawing from the market as far as possible for the time being. On the other hand, many chemicals, such as caustic soda, aqua ammonia, sulphate of ammonia, etc., which are in relatively light supply, have been subject to a particularly heavy demand and prices have accordingly registered material advances.

*Benzol.*—On the whole there has been little activity and in many instances manufacturers have accumulated moderately large quantities, which have been held with more or less steadiness pending the government's requirements regarding purchases of picric acid. The question is now whether or not the government's requirements for T. N. T. will be taken care of. In the event that the T. N. T. cannot be supplied in sufficient quantities, it is almost certain that orders for picric will be forthcoming. Large producers have established a minimum of 55c. for nearby deliveries, and while this price is generally adhered to some concessions are being made by those who are less confident of the future.

Among the benzol derivatives *Aniline Oil* has continued to play a fairly important role, and the market has held with some steadiness, due more to the relatively high cost of production than to any unusual demand; the market for *salts* has been fairly well maintained and those concessions that were made were due mostly to inferior grades. *Paranitraniline* has been quiet and production appears to be somewhat heavier than immediate needs. On contract, prices are shaded materially, although the spot market is not subject to great weakening. *Dimethylaniline* has kept up only because of the increasing cost of production, as export business and domestic orders have been light. *Monocolor benzol* is being produced on a wider scale and important makers have reduced both spot and contract prices.

*Toluol.*—Among all the coal tars this has played the most conspicuous part, due to its importance in the manufacture of explosives as well as in the production of much wanted derivatives. At least four large makers are now under contract for their entire production of T. N. T. for the government and the price paid is based on toluol at \$1.50. For those who have not their own by-product recovery plants the government has been buying toluol, but the attitude of the officials at Washington has changed, and it is stated that T. N. T. makers will hereafter have to supply their own toluol. Small lots of *toluol* are being sold steadily for dye making and as a rule at moderately lower prices than those that prevailed two weeks ago. *Paratoluidine* and *paranitro toluol* have been subject to pressing demand and the output up to this time is hardly taking care of the needs of consumers. *Toluidine* also has been in good request, and with limited supplies the market has been maintained with considerable strength.

*Phenol.*—Apart from the running contract business, routine demand from dyestuffs and intermediate makers, occasional orders from abroad, especially Japan, there has been little activity and prices are not held with any particular strength. Production continues large and is capable of meeting the needs from all directions. *Dinitro phenol* is being made on a larger scale and compe-

tition has induced in some cases a lowering of prices. Contracts are to be had now at fairly large concessions from recent levels. *Para amido phenol* and *paraphenylenediamine* are sought after with comparative steadiness, and some makers have advanced their prices. There is no open market for *picric acid* and until the government expresses a desire for supplies the market will be nominal, with little demand and a small production.

*Naphthaline*.—The absence of wide inquiry has brought prices down fractionally and there is no really important business in progress either for the flakes or balls. Practically all the derivatives of this base are in light demand and prices have declined, some slightly and others materially. The competition for *alpha-naphthylamin* business has induced lower prices, although the output is as a rule being taken up steadily.

*H-acid* (Amido naphthol di sulphonic acid).—Again this intermediate is brought into prominence by the knowledge that one other maker who has been working on the product for a long time has finally been able to offer material quantities for immediate delivery and regular supply.

*Bleaching Powder* has been on the down grade for some time, and both domestic and export containers of all kinds are now available at lower prices than have been in existence for a long time. The facts that paper mills are not busy, that some are using their own liquid bleach, that in summer bleach loses its chlorine strength rapidly, and that export business is negligible, have all been factors in bringing about the weak condition.

*Potash Compounds*.—Muriate has been subject to but light demand, and prices for the syndicate's goods have been reduced materially. A factor has been the importation of more desirable Japanese goods as well as the offerings of domestic kelp potash. *Bichromate of potash* has been inactive, although prices have not fluctuated except within narrow margins. *Caustic potash*. All grades not being under noteworthy buying pressure have eased off somewhat, as manufacturers' supplies have increased. *Carbonate of potash*, both hydrated and calcined, is in light supply, and the most recent business that passed has been at comparatively high levels. *Potash alum*.—Lump prices have been subject to upward revision, due to the demand and higher cost of production.

*Soda Compounds*.—*Caustic soda* has taken by far the most important position as far as active trading is concerned. The market is in a tight position and while there are spot goods here in New York they are held in strong speculative hands and the market is being forced up to high levels. The interest now centers in 1918 contracts to an extent equal to the spot demand and in fact all positions from July delivery to the end of 1918 are subject to weighty demand.

*Soda Ash*.—This market has not followed, as usual, the fluctuations of the caustic market, and prices have remained at comparatively low levels. The absence of heavy demand, of course, is responsible. The fact that steamship companies will not accept ash packed in bags, and are now even stipulating that it must be packed in hardwood casks, has an important bearing on the position, as, on account of the tight cooerage situation, a very large proportion of the output is packed in bags.

*Bichromate of soda* has been moving with moderate briskness, and some makers are still trying to bull the

market now that one maker is out and the productions of two more have been sold up for the next several months. *Silicate of soda* is subject to wide demand and manufacturers are still unable to deliver for some time to come. *Nitrate of soda* has advanced considerably under heavy buying, both for domestic needs and export. *Nitrite of soda* is now being made here in somewhat larger quantities, but as yet only the two large producers are delivering, and their product is sold ahead for some months. The demand is wide and prices are high.

*Ammonia Compounds*.—*Sulphate* production in this country is not taking care of fertilizer needs here, and some of the numerous export orders are going unfilled. *Aqua ammonia* and *nitrate of ammonia* are in such demand that prices, especially of the former, have increased perceptibly every few days and any supplies offered at moderate prices are immediately picked up.

*Acids*.—*Acetic*, especially 80 per cent. redistilled and pure and the glacial, have been offered here during the interval in quantities that have not been available for many months; the result was that the high prices sagged considerably, but the market is strengthening again to near the former levels, as the goods are being sold to go into consumption. *Muriatic acid* is offered at fractionally lower prices and while there is a tendency to maintain certain levels desirable business is given consideration. *Nitric acid*, on account of the higher cost of the nitrate of soda, has been advanced and makers are now endeavoring to get 12c. per unit for all grades; the demand, however, at these levels is not forthcoming and the market is quiet. *Sulphuric acid* (brimstone) has been shaded in a few instances when good orders come into the market, despite the fact that the higher cost and uncertainty of securing brimstone has produced a fundamentally stronger tone. This is more in evidence on future positions and most makes will not take business further ahead than August.

### General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 6, 1917

Acetic anhydride.....	lb.	1 70	—	1.90
Acetone, drums.....	lb.	.29	—	.29½
Acid, acetic, 28 per cent.....	lb.	.05	—	.05½
Acetic, 56 per cent.....	lb.	.10	—	.11
Acetic, glacial, 99½ per cent, carboys.....	lb.	.34	—	.35
Boric, crystals.....	lb.	.13	—	.13½
Citric, crystals.....	lb.	.72½	—	.73
Hydrochloric, commercial, 18 deg.....	lb.	.01½	—	.01½
Hydrochloric, 20 deg.....	lb.	.01½	—	.01½
Hydrochloric, C. P., conc., 22 deg.....	lb.	.01½	—	.01½
Hydrofluoric, 30 per cent, in barrels.....	lb.	.04½	—	.05
Lactic, 44 per cent.....	lb.	.11	—	.12
Lactic, 22 per cent.....	lb.	.04½	—	.05
Nitric, 36 deg.....	lb.	.07½	—	.07½
Nitric, 42 deg.....	lb.	.08	—	.08½
Oxalic, crystals.....	lb.	.33	—	.46
Phosphoric, 85 per cent.....	lb.	.70	—	.75
Picric.....	lb.	3.50	—	4.00
Pyrogallol, resublimed.....	lb.	22.00	—	24.00
Sulphuric, 60 deg.....	ton	29.00	—	30.00
Sulphuric, 66 deg.....	ton	38.00	—	40.00
Sulphuric, oleum (Fuming), tank cars.....	ton	45	—	50
Tannic, U. S. P., bulk.....	lb.	.79	—	.81
Tartaric, crystals.....	lb.	1.80	—	—
Tungstic, basis 100 per cent.....	lb.	3.84	—	3.86
Alcohol, grain, 188 proof.....	gal.	1.00	—	1.02
Alcohol, wood, 95 per cent.....	gal.	1.00	—	1.02
Alcohol, denatured, 180 proof.....	gal.	1.00	—	1.02
Alum, ammonia lump.....	lb.	.04¼	—	.04¾
Alum, chrome ammonium.....	lb.	.19	—	.20
Alum, chrome potassium.....	lb.	.30	—	.32
Alum, chrome sodium.....	lb.	.12	—	.12½
Alum, potash lump.....	lb.	.07½	—	.08
Aluminium sulphate, technical.....	lb.	.02	—	.02½
Aluminium sulphate, iron free.....	lb.	.03	—	.03½
Ammonia aqua, 26 deg. carboys.....	lb.	.07	—	.07½
Ammonium carbonate.....	lb.	.13	—	.14
Ammonium nitrate.....	lb.	.16	—	.17
Ammonium sulphate domestic.....	100 lb.	6.25	—	6.35
Amyl acetate.....	gal.	4.50	—	4.60
Arsenic, white.....	lb.	.17	—	.18
Arsenic, red.....	lb.	.50	—	.60
Barium chloride.....	ton	80.00	—	90.00
Barium sulphate (Blanc Fixe, powder).....	lb.	.04	—	.04½
Barium nitrate.....	lb.	.10½	—	.11
Barium peroxide, 80 per cent.....	lb.	.27	—	.27½

Bleaching powder, 35 per cent chlorine.....	lb.	.01½	—	.02
Borax, crystals, sacks.....	lb.	.07¾	—	.08
Brimstone, crude.....	ton	45.00	—	—
Bromine, technical.....	lb.	.80	—	.90
Calcium, acetate, crude.....	lb.	.03	—	.03½
Calcium, carbide.....	ton	80.00	—	90.00
Calcium chloride, 70-75 per cent, fused, lump.....	ton	26.00	—	28.00
Calcium peroxide.....	lb.	1.60	—	1.65
Calcium phosphate.....	lb.	.30	—	.31
Calcium sulphate.....	lb.	.10	—	.12
Carbon bisulphide.....	lb.	.04½	—	.04½
Carbon tetrachloride, drums.....	lb.	.16	—	.16½
Caustic potash, 88-92 per cent.....	lb.	.83	—	.85
Caustic soda, 76 per cent.....	lb.	.07½	—	.07½
Chlorine, liquid.....	lb.	.15	—	.18
Cobalt oxide.....	lb.	1.55	—	1.60
Copperas.....	100 lb.	1.00	—	1.05
Copper carbonate.....	lb.	.30	—	.32
Copper cyanide.....	lb.	.72	—	.74
Copper sulphate, 99 per cent, large crystals.....	lb.	.09½	—	.09½
Cream of tartar, crystals.....	lb.	.48	—	.49
Epsom salt, bags.....	100 lb.	4.25	—	4.50
Formaldehyde, 40 per cent.....	lb.	.17	—	.18
Glauber's salt.....	100 lb.	.70	—	.75
Glycerine, bulk, C. P.....	lb.	.62	—	.63
Iodine, resublimed.....	lb.	3.50	—	—
Iron oxide.....	lb.	.02	—	.08
Lead, acetate, white crystals.....	lb.	.16	—	.17
Lead arsenate.....	lb.	.12½	—	.13½
Lead nitrate.....	lb.	.17½	—	.18
Litharge, American.....	lb.	.08	—	.19
Lithium carbonate.....	lb.	1.02	—	1.05
Manganese dioxide, U. S. P.....	lb.	.55	—	.60
Magnesium carbonate, tech.....	lb.	.13½	—	.14
Nickel salt, single.....	lb.	.14	—	.14½
Nickel salt, double.....	lb.	.11	—	.12
Phosphorus, red.....	lb.	1.15	—	1.23
Phosphorus, yellow.....	lb.	2.25	—	2.50
Potassium bichromate.....	lb.	.35½	—	.39
Potassium bromide granular.....	lb.	1.00	—	1.05
Potassium carbonate calcined, 80-85 per cent.....	lb.	.70	—	.75
Potassium chlorate, crystals.....	lb.	.52	—	.54
Potassium cyanide, 98-99 per cent.....	lb.	2.25	—	2.25
Potassium iodide.....	lb.	2.00	—	2.92
Potassium muriate 80-85 p. c. basis of 80 p. c.....	ton	350.00	—	360.00
Potassium nitrate.....	lb.	.31	—	.33
Potassium permanganate.....	lb.	4.00	—	4.10
Potassium prussiate, red.....	lb.	2.50	—	2.55
Potassium prussiate, yellow.....	lb.	.98	—	1.05
Potassium sulphate, 90-95 p. c. basis 90 p. c.....	ton	325.00	—	350.00
Rochelle salts.....	lb.	.37½	—	.38½
Sal ammoniac, gray gran.....	lb.	.10	—	.11
Sal ammoniac, white gran.....	lb.	.15	—	.16
Sal soda.....	100 lb.	1.15	—	1.25
Salt cake.....	100 lb.	.90	—	1.03
Silver cyanide.....	oz.	.70	—	—
Silver nitrate.....	oz.	.48½	—	—
Soda ash, 58 per cent, light, flat.....	100 lb.	2.75	—	2.85
Soda ash, 58 per cent, dense, flat.....	100 lb.	3.90	—	4.00
Sodium acetate.....	lb.	.09	—	.10
Sodium benzoate.....	lb.	4.00	—	4.50
Sodium bicarbonate, domestic.....	100 lb.	2.35	—	2.50
Sodium bicarbonate, English.....	lb.	—	—	—
Sodium bichromate.....	lb.	.15½	—	.16
Sodium bisulphite, powd.....	lb.	.03½	—	.04
Sodium chlorate.....	lb.	.24	—	.26
Sodium cyanide.....	lb.	.55	—	.60
Sodium fluoride, commercial.....	lb.	.13	—	.14
Sodium hyposulphite.....	lb.	.01½	—	.02
Sodium nitrate, refined.....	lb.	.06	—	.06½
Sodium nitrite.....	lb.	.45	—	.55
Sodium peroxide.....	lb.	.85	—	.90
Sodium phosphate (tri.).....	lb.	.04½	—	.05
Sodium prussiate, yellow.....	lb.	.29½	—	.30½
Sodium silicate, liquid—40 deg. Baume.....	100 lb.	1.50	—	1.60
Sodium sulphide, 30 per cent crystals.....	100 lb.	2.00	—	2.10
Sodium sulphide, 60 per cent, fused.....	100 lb.	3.00	—	3.50
Sodium sulphite.....	lb.	.03½	—	.04½
Strontium nitrate.....	lb.	.28	—	.30
Sulphur chloride, drums.....	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders.....	lb.	.15	—	.40
Sulphur, flowers, sublimed.....	100 lb.	3.20	—	3.30
Sulphur, roll.....	100 lb.	2.55	—	2.60
Sulphur, crude.....	ton	45.00	—	50.00
Tin bichloride, 50 deg.....	lb.	.19½	—	.20
Tin oxide.....	lb.	.64½	—	.65
Zinc carbonate.....	lb.	.25	—	.27
Zinc chloride.....	lb.	.10½	—	.11
Zinc cyanide.....	lb.	.50	—	—
Zinc dust, 350 mesh.....	lb.	.18	—	.20
Zinc oxide, American process XX.....	lb.	.14½	—	.15
Zinc sulphate.....	lb.	.06	—	.06½

## Coal Tar Products (Crude)

Benzol, pure, water white.....	gal.	.55	—	.60
Benzol, 90 per cent.....	gal.	.53	—	.55
Toluol, pure, water white.....	gal.	1.70	—	1.80
Xylol, pure, water white.....	gal.	.50	—	.55
Solvent naphtha, water white.....	gal.	.19	—	.21
Solvent naphtha, crude, heavy.....	gal.	.13	—	.16
Cresote oil, 25 per cent.....	gal.	.31	—	.33
Dip oil, 20 per cent.....	gal.	.29	—	.30
Pitch, various grades.....	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent.....	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent.....	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent.....	lb.	.32	—	.35
Cresol, U. S. P.....	lb.	.25	—	—

## Intermediates, Etc.

Alpha naphthylamine.....	lb.	.90	—	1.05
Aniline oil.....	lb.	.29	—	.31
Aniline salts.....	lb.	.34	—	.35
Anthracene, 80 per cent.....	lb.	.10	—	—
Benzaldehyde.....	lb.	4.00	—	4.50
Benzidine, base.....	lb.	1.85	—	2.00
Benzidine, sulphate.....	lb.	1.55	—	1.60
Benzoic acid.....	lb.	4.00	—	4.50
Benzyl chloride.....	lb.	1.75	—	2.00

Beta naphthol benzoate.....	lb.	9.00	—	10.00
Beta naphthol, sublimed.....	lb.	.73	—	.75
Beta naphthylamine c.m.....	lb.	2.50	—	—
Dichlor benzol.....	lb.	.11	—	.20
Dinitrochlorbenzol.....	lb.	.46	—	.48
Dimethylamine.....	lb.	.58	—	.60
Diphenylamine.....	lb.	.95	—	1.00
H-acid.....	lb.	3.25	—	3.50
Metaphenylenediamine.....	lb.	1.70	—	1.75
Monochlorbenzol.....	lb.	.23	—	.24
Naphthalene, flake.....	lb.	.09½	—	.09½
Naphthionic acid, crude.....	lb.	1.50	—	1.75
Nitro naphthalene.....	lb.	.45	—	.50
Nitro toluol.....	lb.	.50	—	.55
Ortho-amidophenol.....	lb.	—	—	—
Ortho-toluidine.....	lb.	1.00	—	1.15
Para-amidophenol, base.....	lb.	5.00	—	6.00
Paranitraniline.....	lb.	1.10	—	1.15
Paraphenylenediamine.....	lb.	3.75	—	4.00
Para toluidine.....	lb.	1.00	—	2.00
Phenol, U. S. P.....	lb.	.40	—	.42
Resorcin, technical.....	lb.	8.00	—	9.00
Resorcin, pure.....	lb.	14.00	—	15.00
Salicylic acid.....	lb.	1.35	—	1.45
Salol.....	lb.	1.85	—	2.00
Sulphanilic acid.....	lb.	.32	—	.33
Tolidin.....	lb.	3.00	—	—
Toluidine-mixture.....	lb.	.75	—	.85

## Petroleum Oils

## Crude (at the Wells)

Pennsylvania.....	bbl.	3.10	—	—
Corning, Ohio.....	bbl.	2.40	—	—
Somerset, Ky.....	bbl.	2.20	—	—
Wooster, Ohio.....	bbl.	2.18	—	—
Indiana.....	bbl.	1.78	—	—
Illinois.....	bbl.	1.92	—	—
Oklahoma and Kansas.....	bbl.	1.70	—	—
Cadizo, La., light.....	bbl.	1.90	—	—
Corsicana, Tex., light.....	bbl.	1.70	—	—
California.....	bbl.	.98	—	1.29
Gulf Coast.....	bbl.	1.00	—	—

## Lubricants

Black, reduced, 29 gravity, 25-30 cold test.....	gal.	.13½	—	.14
Cylinder, light.....	gal.	.21	—	.26
Cylinder, dark.....	gal.	.18	—	.19
Paraffine, high viscosity.....	gal.	.29½	—	.30
Paraffine, 903 sp. gr.....	gal.	.21½	—	.22
Paraffine, 865 sp. gr.....	gal.	.18½	—	.19

## Flotation Oils

## (Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940.....	gal.	.52	—	—
Pine oil, destructively distilled, sp. gr. 0.920-0.940.....	gal.	.48	—	—
Pine-tar oil, sp. gr. 1.025-1.035.....	gal.	.25½	—	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990.....	gal.	.35	—	—
Pine oil, light, sp. gr. 0.950 tank cars, f.o.b. works.....	gal.	.37	—	—
Pine oil, heavy, sp. gr. 1.025 tank cars, f.o.b. works.....	gal.	.26	—	—
Pine tar, thin, sp. gr. 1.060-1.080.....	gal.	.22	—	—
Turpentine, crude, sp. gr. 0.980-1.000.....	gal.	.40	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990.....	gal.	.19	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08.....	gal.	.19	—	—

## Vegetable and Other Oils

China wood oil.....	lb.	.16½	—	.16½
Cottonseed oil, crude.....	gal.	1.07	—	—
Lined oil, raw, cars.....	gal.	1.15	—	—
Peanut oil, crude.....	gal.	1.15	—	—
Rosin oil, first run.....	gal.	.36	—	—
Rosin oil, fourth run.....	gal.	.66	—	—
Soya bean oil, Manchuria.....	lb.	.14½	—	—
Turpentine, spirits.....	gal.	.43	—	—

## Miscellaneous Materials

Barytes, floated, white, foreign.....	ton	38.00	—	40.00
Barytes, floated, white, domestic.....	ton	28.00	—	32.00
Beeswax, white, pure.....	lb.	.60	—	.65
Carnauba wax, flr.....	lb.	.53	—	—
Casein.....	lb.	.19	—	.28
Chalk, light, precipitated, English.....	lb.	.03	—	.06
Feldspar.....	ton	8.00	—	12.00
Fuller's earth, powdered.....	100 lb.	1.00	—	1.50
Ozokerite, crude, brown.....	lb.	.60	—	.70
Ozokerite, American.....	lb.	.35	—	—
Red lead, dry, carloads.....	lb.	.13	—	—
Rosin, 280 lb.....	bbl.	6.00	—	—
Soapstone.....	ton	10.00	—	12.50
Talc, American, white.....	ton	10.00	—	13.00
White lead, dry.....	lb.	.11½	—	—

## Refractories, Etc.

## (F.O.B. Works)

Chrome brick.....	net ton	Nominal	—	—
Chrome cement, Grecian.....	net ton	Nominal	—	—
Clay brick 1st quality fireclay.....	per 1000	45.00	—	50.00
Clay brick, second quality.....	per 1000	30.00	—	—
Magnesite, raw.....	ton	30.00	—	35.00
Magnesite, calcined.....	ton	40.00	—	55.00
Magnesite, Grecian, dead burned.....	net ton	90.00	—	—
Magnesia brick, Grecian, 9x4½x2½.....	net ton	140.00	—	—
Silica brick.....	per 1000	50.00	—	—

## Ferroalloys

Ferrocobaltititanium, 15-18 per cent, car loads, f.o.b. Niagara Falls, N. Y.....	ton	160.00	—	—
Ferrocobaltititanium.....	lb.	Nominal	—	—
Ferromanganese, domestic, delivered.....	ton	400.00	—	425.00
Ferromanganese, English.....	ton	200.00	—	—
Ferromolybdenum, per lb. of Mo.....	lb.	4.50	—	—
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh.....	ton	200.00	—	225.00
Ferrosilicon, 50 per cent, contract.....	ton	100.00	—	—
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh.....	lb.	2.65	—	—
Ferrovanadium, f.o.b. works.....	lb.	3.25	—	3.50



# INDUSTRIAL

## Financial, Construction and Manufacturers' News

### Financial

#### New Companies

The Advance Chemical Company, Wilmington, Del., has been incorporated with capital of \$1,000,000 to manufacture chemicals, etc. The incorporators are: M. L. Rogers, L. A. Irwin and Harry W. Davis, all of Wilmington.

American Foundry Company, Inc., Elizabeth, N. J., has been incorporated with a capital of \$125,000 to conduct a foundry business. Incorporators are Mary T. McCartney, Rahway; Morris Jagger, Otto Froebel, Elizabeth.

The Beaver Chemical Company, Inc., New York, has filed articles of incorporation with capital of \$10,000 to manufacture chemicals, etc. The incorporators are H. and B. Lichtenberg and S. Fillin, all of New York.

The Brettler Sheet Metal Works, New York, has been incorporated with a capital of \$10,000 to manufacture iron floor plates. B. Brettler, the principal incorporator, operates a metal working plant at 227 East 47th Street. A. and M. Brettler are the other incorporators.

Charleston Alloy Steel Company, Belle, W. Va., has been incorporated with a capital of \$500,000 to manufacture iron, steel, manganese, coke, copper, lumber and other minerals. The incorporators are J. M. Payne, Berkeley Minor, Jr., J. F. Bouchelle, E. A. McCoy and G. P. Brennan, all of Charleston.

The Clarke-Kessler Company, Wickliffe, Ohio, has been incorporated with a capital of \$250,000. Incorporators are H. W. Kessler, C. R. Kessler, G. W. Clarke, Edgar J. Tyler and J. M. Shallenberger.

The Clement Synthetic Gas & Chemical Co., Inc., New York City, N. Y., has been incorporated with a capital of \$5,000 to manufacture chemical compounds, dyestuffs, airplanes, automobiles. Incorporators are L. Clement, R. T. Grogan, H. Boes, 119 E. 88th St.

Wm. M. Crellin & Co., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture chemicals, oils, greases, etc.

The Crescent Rubber Corporation, Chicago, has been incorporated under Delaware laws and capital of \$1,500,000 to manufacture rubber and rubber products. The incorporators are: F. R. Kelley, Elgin, Ill.; George H. Gilberda, and R. S. Hanford, of Chicago.

Cuban Air Reduction Corporation, New York City, N. Y., has been incorporated with a capital of \$267,500 to manufacture oxygen, nitrogen and other constituents of oil. Incorporators are F. A. Huchk, J. B. Kilburn, C. F. Wicker, 60 Broadway.

The Cumberland Petroleum & Refining Company has been incorporated in Delaware with a capital of \$1,000,000 to produce and market oil and petroleum. Incorporators are John F. Sever, Kansas City, Mo.; R. C. Clapp, U. S. Barr, Wichita, Kans.

The Delion Tire & Rubber Company, Trenton, N. J., has been incorporated under Delaware laws with capital of \$3,500,000 to manufacture rubber goods of different kinds. The company has a plant on East State Street, and is now building two 1-story additions, about 50 x 100 ft., and 25 x 65 ft.

The Delta Iron & Furnace Company, Chicago, has been incorporated with Delaware charter and capital of \$5,000,000 to operate iron properties. Richard H. Hollen, John A. Massen and DeGroot Van Baekeman, all of Chicago, are the incorporators.

Dixie Chemical Corporation, Petersburg, Va., has been incorporated with a capital of \$180,000. Incorporators are C. W. Stratford, president, New York; W. J. Sommers, secretary-treasurer, Petersburg.

The Dural Rubber Company, Trenton, N. J., has been incorporated with a capital of \$200,000 to manufacture rubber and other specialties. The company has acquired a site at Flemington, N. J., and plans for the immediate establishment of a plant for the manufacture of automobile tires, rubber goods for aircraft and aeroplane parts. Edgar H. Wilson, Trenton, is president. Other incorporators of the company are Newton A. K. Bugbee, James C. Tattersall, H. M. Voorhees and John G. Connor. Local offices have been established at Room 711 Broad Street Bank Building.

Durex Aniline Works, Inc., New York City, N. Y., has been incorporated with a capital of \$10,000 to manufacture dyes, paints and chemicals. Incorporators are S. E. Baer, H. M. and M. Toch, 325 West 86th Street.

Durham Paper & Pulp Company, Phillipsburg, N. J., has been incorporated with a capital of \$125,000 to manufacture paper, paper materials, pulp, etc.

Edgewood Glass Company, Hamilton, Ill., has been incorporated with a capital of \$125,000. Incorporators are W. A. Raybourne, E. F. Phillips, William Sinton, W. S. Phillips, Jacob Scheuton, F. A. French.

The Empire Smelting & Refining Company of Chicago have been granted a permit to do business in Texas, with a capital stock of \$100,000, with headquarters at San Antonio and El Paso.

Freeport Chemical Company, Freeport, Tex., has been incorporated with a capital of \$100,000 to manufacture sulphur products. Incorporators are Christian B. Sanbriskie, New York City; Christian De Guigno, Jr., Hillsborough, Cal.; George P. Howard and William A. Vinson of Houston.

Gillillan Bros. Smelting & Refining Co., Los Angeles, Cal., has been incorporated with a capital of \$100,000. Incorporators are S. W. Gillillan, C. F. Gillillan, I. G. Brown, A. W. Klusmann and G. L. Alspach.

Greenback Mining & Smelting Company, Wilmington, Del., has been incorporated with a capital of \$250,000 to conduct a general mining business.

C. H. Hall, Plainfield, N. J., has been incorporated with a capital of \$25,000 to manufacture and deal in drugs, chemicals, etc. Incorporators are Charles H. Hall, Elizabeth T. Hall and Louis P. Wilson, Plainfield.

T. O. Horne Company, Pleasant Unity, Pa., has been incorporated with a capital of \$10,000 to manufacture iron and steel. Incorporator, Mary E. Horne.

Indian Copper Company has been incorporated in Delaware with a capital of \$100,000 to carry on business of reducing smelting and mining of gold, silver, copper, etc. Incorporators are Arthur W. Britton, Henry O. Coughlan, George V. Reilly, all of New York.

Independent American Oil & Sulphur Corp. has been incorporated in Delaware with a capital of \$15,000,000 to acquire lands containing oil, natural gas, sulphur and other minerals, etc. Incorporators are A. M. Halloran, M. H. Morris, F. Giles, local, Wilmington, Del.

International Alcohol Corporation has been incorporated in Delaware with a capital of \$4,000,000 to manufacture alcohol from sawdust, wood wastes and other substances. Incorporators are L. E. Rebori, Frank Cusick and A. Sheard, New York City.

The International Chemical Company, Washington, D. C., has been incorporated under Delaware laws with capital of \$100,000 to manufacture chemicals and kindred products. The incorporators are William H. Forman, Thomas J. Hall, Washington, and Charles G. Guyer, Wilmington, Del.

I. G. Jones Co., Inc., Syracuse, N. Y., has been incorporated with a capital of \$50,000 to manufacture engines, boilers, petroleum and products, chemicals, asbestos and fireproofing, electrical machinery, plumbers' supplies. Incorporators are I. G. Jones, H. L. Betts, F. C. Faulkner, Syracuse.

The Kaolin Refining Co., 608 Hyde Building, Spokane, Wash., has been incorporated with a capital of \$100,000 by D. C. Neafus, Cyrus Happy and John J. Kyle. The company owns clay beds north of Spokane, near Deer Park, Wash., containing a large amount of kaolin and ochre. The kaolin analyzed 51.22 per cent silica, 33.52 per cent alumina, 1.72 per cent iron, trace of magnesia, 9.62 per cent alkali, 2.34 per cent fluxes, 1.38 per cent moisture. Loss on ignition, 11.36 per cent. The company intends to build a mill of 30-40 tons' capacity. The mill will be equipped with a flotation plant to separate the grit from the kaolin.

Kenwood Oil Corporation has been incorporated in Delaware with a capital of \$10,000,000 to acquire lands containing oil, coal and iron and develop same. Incorporators are A. M. Halloran, M. H. Morris, Ferris Giles, Wilmington, Del.

The Lake Shore Chemical Co., Cleveland, Ohio, has been incorporated with a capital of \$200,000. Incorporator, Francis Seiberling.

The Landon Corporation, South Bend, Ind., has been incorporated with a capital of \$350,000 to manufacture chemicals and chemical compounds. Incorporators are Georgia V. Landon, Lewis C. Landon, Carl S. Ayres.

The Lignitra Fibre Products Co., Barberton, Ohio, has been incorporated with a capital of \$150,000. The incorporator is Kenneth S. Smith.

Linden Chemical Company, Linden, N. J., has been incorporated with a capital of \$125,000 to manufacture and deal in chemicals. Incorporators are Adam J. Traub of Elizabeth and Norman W. Kempf and Louis A. Kempf of Newark.

Lippincott Chemical Company, Inc., New York City, N. Y., has been incorporated with a capital of \$25,000 to manufacture chemicals, drugs, compounds, etc. Incorporators are W. A. Lippincott, Great Neck, L. I.; B. Berkow, 524 West 34th Street, J. F. Russell, Jr., 43 Cedar Street, New York City.

The Metallograph Corporation, New York, has filed articles of incorporation with capital of \$540,000 to operate a refining works for brass, copper and other metals. The incorporators are I. M. Berliner, F. Spungin and J. J. Cohen, 135 West 115th Street.

National Castings Company, Carlisle, Pa., has been incorporated with a capital of \$50,000 to manufacture iron and steel. Incorporator: J. H. Foreman, treasurer.

Newcomb Iron & Steel Company, New York, has been incorporated with a capital of \$10,000 to manufacture railway equipment. Incorporators are Albert C. Smith, Paul V. Hoyer, Irving H. Schafer.

The Philadelphia Wax Paper Company, Philadelphia, Pa., has been incorporated with a capital of \$150,000 to operate a local plant. S. W. Stanage is the principal incorporator.

The Allen W. Phillips Smelting Company has been incorporated with a capital of \$50,000 to manufacture steel. The incorporators are Allen W. Phillips, president; Charles Bloss, treasurer, and Dr. Louis Millet, secretary, and others.

The Prestotite Company, Wilmington, Del., has been incorporated with a capital of \$50,000 to manufacture and sell "Prestotite" and other chemical compounds.

Radcliffe Color & Chemical Works, Elizabeth, N. J., has been incorporated with a capital of \$50,000 to manufacture and deal in colors and dyes. Incorporators are David D. Radcliffe, John J. Smith, Elizabeth; John H. Strawbridge, Hillside Township, Union County.

Rahway Chemical Manufacturing Company, Rahway, N. J., has been incorporated with a capital of \$25,000 to manufacture chemicals. Incorporators are I. S. Joseph, G. H. Adler, J. B. Elsemann, Rahway.

The Refractory Magnesite Corporation, New York, has been incorporated in Delaware with capital of \$100,000 to operate copper, manganese iron and other ore properties. Arthur W. Britton, Louis H. Gunther and Joseph F. Curtin, all of New York, are the incorporators.

The Rhode Island Foundry & Machine Company, Providence, R. I., has been incorporated with a capital of \$100,000. Incorporators are Henry S. Chaffee, Dwight K. Bartlett and Samuel Raynor.

Rockford Union Foundry Company, Rockford, Ill., has been incorporated with a capital of \$25,000. Incorporators are Hugo L. Olson, W. A. Brollin, Shelby L. Large.

Rom-Baw Chemical Co., Inc., Clinton, N. Y., has been incorporated with a capital of \$25,000 to manufacture furniture polish, varnishes and chemicals. Incorporators are G. H. and M. E. Allen, E. D. Hunter, Clinton.

Sanlis Valley Land & Mining Company, Philadelphia, Pa., has been incorporated with a capital of \$3,000,000 to engage in a general mining, milling and refining of ores. Incorporators are F. R. Hansell, J. Vernon Fimm of Philadelphia, and S. C. Seymour, Camden, N. J.

The Stamping Products Corporation, New York, has been incorporated with a capital of \$25,000 to manufacture metal molds, etc. C. A. Anderson, S. B. Sherman and G. C. Steeves, 630 West 141st Street, New York, are the incorporators.

The Stanley Vehicle Spring Company, Syracuse, N. Y., has filed articles of incorporation with capital of \$100,000 to manufacture steel springs of different kinds. F. W. Green, W. H. Robinson and H. P. Denison, all of Syracuse, are the incorporators.

Sterling Refining Company, Evansville, Ind., has been incorporated with a capital of \$10,000 to manufacture sugar, candies and kindred products. Incorporators are Charles F. Hartmetz, Heenry A. Wimberg, George P. Stocker.

The Taylor Turpentine Company, Mobile, Ala., has been incorporated with a capital of \$100,000. Incorporators are S. and A. Lowenstein and Thos. J. Taylor, H. C. Taylor.

The Texas Production Company has been incorporated under Delaware laws with capital of \$1,000,000 to operate oil properties. M. H. Morris, A. M. Halloran and Ferris Giles, Wilmington, are the incorporators of the company.

Texas Sulphur Royalty Company, Wilmington, Del., has been incorporated with a capital of \$50,000 to acquire mining claims and develop same. Incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del.; Clement M. Egner, Elkton, Md.

Thomas & Betts Co., Elizabeth, N. J., has been incorporated with a capital of \$300,000 to act as merchants and deal in chemicals. Incorporators are Robert McK. Thomas, Meandham; Hobart D. Betts, Englewood; Adnah McMurtrie, New York City.

Virginia Chlorine Products Corp. has been incorporated in Delaware with a capital of \$1,500,000 to manufacture all kinds of dyes, chemicals, etc. Incorporators are C. J. Kulberg, New York; H. Van Arsdale, Newark, N. J.; D. A. Woodcock, Passaic, N. J.

Warren Products Co., Inc., New York City, N. Y., has been incorporated with a capital of \$10,000 to manufacture chemicals and drugs. Incorporators are F. L. Cramer, D. K. Hill, H. R. Harrison, 120 Broadway.

The Wilson Oil & Gas Company, Zanesville, Ind., has been incorporated with a capital of \$9,000 to sink and operate oil and gas wells. Incorporators are Charles I. Weirich, J. A. Prough, Jasper C. Middaugh, John Miller, James L. McBride.

Wonder Paper & Fabric Company has been incorporated in Delaware with a capital of \$2,100,000 to manufacture and sell paper of all kinds. Incorporators are Herbert E. Latter, Henry Robinson, Wilmington, Del., and Clement M. Egner, Elkton, Md.

O. W. Young, Inc., Newark, N. J., has been incorporated with a capital of \$25,000 to manufacture and deal in lubricating and illuminating oils. Incorporators are Joseph T. Davey, Kate F. Montrose, Patrick A. Hlewith, Newark; Clarence H. Smith, Linden.

### Changes of Ownership, Capital, Increases, Etc.

Harrisons' Incorporated, paint manufacturers of Philadelphia, recently purchased by E. I. du Pont de Nemours & Co., have just completed an important purchase which rounds out their business and gives them control of colors and chemicals needed in the manufacture of paint which they have hitherto purchased from other producers. This deal involves an expenditure of about \$2,000,000 and gives the Harrison Company control of the Beckton Chemical Company, with plants in Newark, N. J., and in Philadelphia, and of Canby Clark & Co., with plants in Newark, N. J. The Beckton Company was controlled by Canby Clark & Co., and the purchase by Harrisons' Incorporated, includes the stock of both companies. Canby Clark & Co.'s factories manufacture colors for paints, paper, ink, etc., as well as chemicals used in the paint industry. The Beckton Company is a large producer of acids and lithopone.

The American Briquette Company, Philadelphia, Pa., has increased its capital from \$25,000 to \$200,000 for expansion.

The United States Metals Reduction Company, Pittsburgh, Pa., a Delaware incorporation, has increased its capital from \$100,000 to \$300,000 to provide for business extensions.

The Fiske Brothers Refining Company, 24 State Street, New York, has increased its capital from \$100,000 to \$300,000.

The Essex Rubber Company, May and Beakes streets, Trenton, N. J., manufacturer of mechanical rubber goods, has increased its capital from \$500,000 to \$700,000.

The Simpson Gasoline Company, Bradford, Pa., has increased its capital from \$95,000 to \$200,000 for expansion.

The Shields Oil & Gas Company, Pittsburgh, Pa., a Delaware incorporation, has increased its capital from \$50,000 to \$100,000 for extensions.

The Iroquois Foundries, Utica, N. Y., has increased its capital from \$25,000 to \$75,000 to provide for business extensions.

## Construction and Operation

### Alabama

BIRMINGHAM.—The United States Steel Corporation has appropriated \$11,000,000 for extensions to the plant of the Tennessee Coal, Iron & Railroad Company at Birmingham. The extensions will be used for manufacturing products of commercial use at the present time.

MOBILE.—Several veneer plants have been established recently in the southern part of the State. A new plant will be finished at Ellisville and similar one at Jeffris, La., across the river from Natchez.

### Arizona

JEROME.—Actual work on the construction of the United Verde Extension smelter is under way. It is understood that there has been a reversal of the plans for driving a two-mile tunnel and that for some time the ore will continue to be hoisted and delivered to the railroad through a service tunnel at a much higher level. On account of the strike the May output was cut down about 1,000,000 lb. The shortage of production for June will probably be 1,700,000 lb. from the same cause.

### Arkansas

LITTLE ROCK.—The Arkansas Lime Company is planning the erection of a \$25,000 plant to grind glass sand. The erection of several glass factories at Fort Smith has created a demand for this product.

### California

BERKELEY.—The Philadelphia Quartz Co. of Philadelphia has recently incorporated under the California laws and will manufacture silicate of soda in a new plant which will be built here.

MARTINEZ.—The Theodore Dittell Company has commenced erection of a glass-sand, silica and clay refining plant near Antioch. The company will refine glass sand and china clay.

SAN FRANCISCO.—The Amalgamated Paint Co. of New York, manufacturer of marine paint, will establish a Pacific Coast plant to be located on San Francisco Bay.

### Colorado

RENO.—Mr. J. C. Moore of New York, together with two engineers, is investigating the possibilities of extracting potash from the waters of Lakes Summer and Abert, near Lakeview. It is understood that a plant will be erected. A branch railroad will be constructed to connect with the Western Pacific.

### Delaware

WILMINGTON.—The Standard Kid Mfg. Company, recently incorporated, has commenced the operation of a plant on Monroe Street for the manufacture of glazed kid and kindred leather specialties. The company has a capitalization of \$42,000. The officers, formerly associated with F. Blumenthal & Company, Wilmington, are R. C. McMullen, vice-president, and P. A. Monigle, secretary.

### Georgia

SAVANNAH.—The new plant of the Savannah Sugar Refining Company was recently put in operation. The refinery has a capacity of 150,000 tons of sugar annually and is the only one between Philadelphia and New Orleans. The directors are Henry T. Oxnard, Robert Oxnard, James Imbrie, Mills B. Lane, J. H. Hunter, B. A. Oxnard.

### Idaho

COEUR D'ALENE.—It is reported that the Coeur d'Alene Mining Company has uncovered 8 ft. of high-grade antimony ore at its Pine Creek property, said to be the largest body of antimony ever uncovered in Idaho. Of the ore fully 3 ft. is first-class shipping product and balance is mill feed free from impurities.

KELLOGG.—Ore to be used in the initial charge of the \$1,000,000 smelter of the Bunker Hill & Sullivan has reached the plant, and it is expected that the smelter will begin operations in the very near future. Every section of the big plant is built so that an increase in capacity can be made with the least expense and briefest expenditure of time. The first ore to be treated will be that produced by the company mines, but the opening of the plant to custom trade will make necessary an early expansion. The plant will be in charge of M. H. Sullivan, former assistant superintendent of the Trail Smelter of the Consolidated Mining & Smelting Company, who has had charge of construction of the plant. The company has announced that, effective June 1, all employees of the Bunker Hill & Sullivan smelter were granted a bonus of 75 cents a day. About 300 smelter employees are affected.

NEZ PERCE.—The plant of the Nez Perce Brick & Tile Factory will begin operations at once. Work of installing machinery has been completed.

### Maryland

BALTIMORE.—The Penn-Mary Steel Company is taking bids for the erection of a new one-story concrete copper shop, about 60 x 121 ft.

### Michigan

MONROE.—The Monroe Chemical Company will occupy temporarily part of the old Monroe Glass Company for the manufacture of chemicals. The company is a new one.

### Montana

BUTTE.—Considerable difficulty is being experienced in the mining district adjacent to Butte by partial strikes at the various properties. The Davis-Daly copper mine, Anaconda Copper Company, the Elm Orlu property, and a number of others have been affected. No disorders of any kind marked the strike, and a number of the men have returned to work.

LIVINGSTON.—H. A. Bacorn and associates have plans under way for the mining of sheelite in Park County. The company plans to immediately open the tungsten and gold mines at Jardine.

### New Jersey

BAYONNE.—The National Sulphur Company has awarded a contract for the erection of a two-story reinforced-concrete addition to its plant to cost \$20,000. The H. D. Best Company, 52 Vanderbilt Avenue, New York, are the contractors.

BOGOTA.—The Federal Paper Board Company has awarded a contract for the erection of a one-story brick addition to its plant on the River Road.

ELIZABETH.—The Linden Tanning Company, leather manufacturer, is planning the erection of an addition to its plant which will cost \$250,000.

HARRISON.—The Crucible Steel Company, South Fourth Street, will build a new one-story shop building about 200 x 400 ft., to be used for forging work. The company will also build a new steel mill in the Lawrenceville district, near Pittsburgh, Pa., to cost about \$125,000.

JERSEY CITY.—The Seydel Manufacturing Co.'s plant in which aniline dyes and chemicals were made was destroyed by fire several days ago at a loss of \$150,000. A huge pot of benzoic acid boiled over during the fire and caused a great deal of confusion, all the workmen leaving.

NEWARK.—The Alcohol Products Company has had plans prepared for a new plant at the foot of Blanchard Street to cost about \$75,000, for the manufacture of alcohol and chemical specialties. The structures will include a main refining works to be two stories, reinforced-concrete, about 62 x 85 ft., one-story building, 40 x 40 ft., and engine and boiler house for plant operation, 32 x 35 ft. Frederick A. Phelps, Union Building, is architect.

NEWARK.—The Universal Smelting & Refining Company will build a new one-story, brick and steel plant, 110 x 450 ft., at 154 St. Charles Street, to cost about \$154,000. The plant will be used for the production of tin, lead, etc. Plans for the erection have been filed.

NEWARK.—The American Leather Mfg. Company, 488 Frelinghuysen Avenue, has filed plans for the erection of two one-story additions to its plant at New and Nutman Streets, about 25 x 45 ft., and 11 x 35 ft., respectively.

NEWARK.—The Dooner & Smith Chemical Company, 258-60 New Jersey Railroad Avenue, has filed plans for the construction of a one-story addition to its plant, about 50 x 86 ft.

NEWARK.—H. F. Sommer & Company, 219 Hamburg Place, manufacturer of leather, has filed plans for the erection of a new one-story tannery addition.

NEWARK.—The General Alloy Company, 59 Bruen Street, has filed notice of organization to operate a local plant for the production of different alloys. Davis Rosen is head.

NEWARK.—J. L. Armitage & Company, 54 Dawson Street, manufacturer of paints and varnishes, will build a one-story reinforced-concrete addition to its plant, about 30 x 60 ft.

NEWARK.—The Celluloid Company has filed plans for the erection of a one-story addition to its plant, about 30 x 69 ft., at 51 Westcott Street.

RIDGEFIELD PARK.—The Bergen Paper Company will build a two-story addition to its plant, about 60 x 85 ft., to cost \$15,000.



### New York

**LEROY.**—The LeRoy Electric Porcelain Company will increase the capacity of its plant for the manufacture of electric porcelain specialties. Four new kilns will be erected.

**LOCKPORT.**—The Lockport Paper Company, Mill Street, manufacturer of paper, will build a one and two-story reinforced-concrete addition to its plant, about 40 x 110 ft. Harry Nichols is general manager.

**LOCKPORT.**—The Simonds Mfg. Company, Ohio Street, manufacturer of saw steel, will build a one-story extension to its plant, about 55 x 165 ft.

**WATERTOWN.**—The Brownsville Paper Company will erect a large addition to its plant this summer.

### Ohio

**CINCINNATI.**—A company to be known as the Elferose Sugar Company has been formed for making a special kind of sugar and syrup not now attainable in the United States. J. W. Freiberg of the Freiberg & Workum Company, is interested.

### Oregon

**OREGON CITY.**—A strike of 100 employees of the Crown-Willamette Paper Company, resulting in complete close-down of the mills, has been settled satisfactorily. Coincident with the settlement the company announced a bonus of 50 cents a day for all its employees, effective June 1. New bonus takes the place of a graduated bonus of from 50 to 25 cents, based on the wage rate of the employee, which has been in force for some time.

**ROSEBURG.**—Charles W. Jones of Portland, expects to establish a fertilizer plant on the property of the Oregon-Portland Cement Company near Roseburg. It is said the property contains an unlimited supply of lime rock suitable for manufacture of farm products, and a plant costing \$100,000 is to be installed.

### Pennsylvania

**EASTON.**—The Standard Processing Steel Corporation has increased its capital from \$300,000 to \$500,000 for expansion. It is proposed to increase the capacities of the present steel and iron foundries; the output of the latter department will be doubled. The work is estimated to cost \$100,000. O. L. Mills is president.

**PHILADELPHIA.**—The Penn Chemical Company has awarded a contract for the erection of a three-story brick and concrete addition, about 25 x 50 ft., on Washington Avenue. The new works, with power house, will cost \$75,000.

**PHILADELPHIA.**—J. F. Johnson & Company, operating automobile repair shops at 2317 North Sixteenth Street, are taking bids for the construction of a new two-story gage and tool shop, 30 x 115 ft., at Ninth and Tioga Streets.

**PHILADELPHIA.**—C. F. Simonin's Sons, Tioga and Belgrade Streets, manufacturers of oils, etc., have awarded a contract for the erection of a one-story addition, about 75 x 90 ft., to cost \$15,000.

**PHILADELPHIA.**—Fire recently destroyed a portion of the plant of the Barrett Manufacturing Company, Tucker and Bermuda Streets, with loss estimated at \$40,000. The plant will be rebuilt.

**PHILADELPHIA.**—The Crew Levick Company, Land Title Building, manufacturer of oils, has commenced the preparation of plans for its new oil plant to be located on Pettys Island in the Delaware River, opposite Philadelphia, to comprise about ten buildings. This company is one of the properties of Henry R. Doherty Company, 60 Wall Street, New York.

**PHILADELPHIA.**—The India Refining Company, Swanson and McKean Streets, manufacturer of refined oils, has filed plans for the erection of an addition to cost about \$25,000.

**PITTSBURGH.**—The Knox Pressed & Welded Steel Company of Wheatland and the Blaw Steel Company of Pittsburgh have combined. The new firm is to be known as the Blaw-Knox Steel Company and will be capitalized at \$1,400,000. The Blaw company has a large plant in Pittsburgh, where it manufactures steel and copper and other products. The Knox plants are located in Sharon and Wheatland.

**PITTSBURGH.**—The Damascus Bronze Company, 929 South Avenue, manufacturer of brass and bronze castings, babbitt metal, etc., has filed plans for a new one-story foundry on Reedsdale Street to cost about \$25,000.

**WARREN.**—The Warren Oil Company has acquired about ten acres of property

near the city and plans for the construction of a new oil and blending works to cost about \$50,000.

### Tennessee

**CHATTANOOGA.**—The Chattanooga Gas & Coal Products Company will increase the capacity of its coke manufacturing plant at Alton Park by the installation of 24 new ovens, at an estimated cost of about \$500,000. The plant will have a capacity of about 300 tons of coke daily. The Smet-Solvay Company, Solvay, N. Y., has the contract for erection.

### Utah

**SALT LAKE CITY.**—A new company known as the Western Phosphate Mining & Manufacturing Company, will locate a plant near Paris, Idaho, in a field of phosphate rock.

### Virginia

**LYNCHBURG.**—The Glamorgan Pipe Foundry Company has awarded a contract for the erection of an addition to its plant, about 40 x 80 ft., to cost \$20,000.

**NEWPORT NEWS.**—The War Department has awarded a contract for the construction of a large manufacturing plant to make hydrogen for balloons. The gas will be made at the Government aviation station.

### Washington

**EVERETT.**—The Western Talc Company here recently began work of opening a large body of talc near Reardan, Wash. The company will begin shipping as soon as machinery for the mill has been installed.

**MORTON.**—A. R. Rutherford, here, announces that the group of cinnabar mines near Morton have been sold to a new concern and that a large crew of men will be put at work immediately to reduce the immense quantity of low-grade ore in sight to quicksilver.

**SPOKANE.**—The Humane Stock Remedies Company here will immediately rebuild its lime-sulphur solution plant which was destroyed by fire on May 17, the new plant to have a capacity double that of the old one. The company will also build and equip a large new furnace room.

**SPOKANE.**—Northwestern Magnesite Company of Spokane has awarded a contract for the construction of a tramway 25,000 ft. long. The net fall is 430 ft. and the capacity 60 tons per hour. The tramway will deliver magnesite from the company's properties to their mill near Chewelah, Wash. The tramway will be built by the Riblet Tramway Company, who will also build a tramway for the Engels Copper Mining Company of Engels, Cal.

**TACOMA.**—By combining two small plants and doubling the stock and number of workmen employed, J. S. Menefee, manager of W. F. Fuller & Company here, has created the largest plant in the Northwest for the manufacture of mirrors, art glass and bevel plate. The two plants consolidated are the Myborn Company and Destiny Art Glass Works, both on A Street, Tacoma. The enlarged plant has been located in the Ferguson Building at 1205 A Street, and will be known as Fuller's Art Glass, Mirror & Bevel Plate Works, a branch of W. F. Fuller & Co.

### West Virginia

**CLARKSBURG.**—Many new companies are coming to West Virginia for coal in spite of the natural gas shortage. The shortage of natural gas in several other States has caused industrial companies to pick locations where coal is readily available.

**WHEELING.**—The Hazel-Atlas Glass Company plans another addition to its plant.

### British Columbia

**AINSWORTH, B. C.**—The concentrates of the Silver Hoard mine here are running high, according to report of W. S. Hawley of Spokane. Concentrates show 65 per cent lead, 150 ounces in silver and 45 per cent zinc. As soon as machinery is adjusted it is expected this can be raised to 70 per cent lead and 50 per cent zinc, with a recovery of 85 to 90 per cent. The flotation plant will begin operation July 1.

**KAMLOOPS, B. C.**—The local board of trade has approached the Provincial Government for the construction of a smelter in this district for the treatment of low-grade ores. The Minister of Mines announces that it is not the intention of the government to erect any smelters in 1917, but the claims of Kamloops will be investigated.

**NELSON.**—The Molly Mine, next to the largest molybdenite mine in Canada, is to be immediately equipped with a large mill. Figures show that the mine ranks second as the largest producer of molybdenite and one of the most important of the country's munition properties.

**NEW WESTMINSTER.**—The Western Canada Lime Company has achieved considerable success since its opening. Plant has been handicapped by lack of available labor, but its product, pulverized lime rock, has been very popular.

**PENTICTON.**—The Canada Copper Corporation, Mr. Ashmund, general manager, is completing plans for equipping the mine at Copper Mountain for a production of 2,000 tons daily; installation of a power plant, and mill capable of handling this tonnage. About 600 employees will ultimately be required. Mill will be built on the Similkameen River and the oil flotation process will be used.

**PORT COQUITLAM.**—Voters will shortly pass on a by-law to be submitted to them to bonus the proposed steel works plant to the extent of \$200,000, of which A. F. Bernstein of Vancouver, and associates, will be the founders. The proposition is that the Steel Company shall spend \$800,000 in the establishment of a plant to turn out 75 tons of steel daily.

**TRAIL.**—In spite of lack of coke, shortage of labor, high costs of operation and other difficulties, the big smelter and refinery here has continued to handle ore. During the last week in May 5669 tons of ore were received at the smelter. The total for the month of May, however, dropped to 15,364 tons, the lowest of any month during the year.

**TRAIL.**—It is expected that the new concentrator of the Consolidated Mining & Smelting Company here will be completed, the equipment of machinery installed, and the plant in operation. Wilfey tables and other machines are now being placed and arrangements made for using the oil flotation process in the concentration of the company's Sullivan mine complex ores, for which the plant is primarily intended. The plant will have capacity of 200 tons daily, and is erected as an experimental plant. If successful, a much larger plant will be erected.

**VANCOUVER.**—One unit of the Pacific Mills, Ltd., at Ocean Falls, capable of producing 75 tons of newspaper stock daily, has been put into operation. This plant is the first unit of an ultimate development of 195 tons.

**VANCOUVER.**—Hematite Mining Company has been reorganized with capital stock of \$45,000.

**VANCOUVER.**—The Canadian Collieries are building 150 coke ovens at Union Bay. It is expected that the Kootenay-Boundary smelters will be able to get some coke from the coast.

**VANCOUVER.**—The Rainy River Pulp & Paper Company has commenced manufacture of paper at its Port Mellon, Howe Sound mill, the first four units of the plant having begun operation. The plant was changed in record time from a soda process mill to a kraft process mill, having been bought by Eastern capitalists early in February. It is the only plant using the kraft process on the Pacific Coast.

**VICTORIA.**—Hon. William Sloan has introduced a bill in Legislature to permit the department of mines to go into the smelter business if warranted, urging its passage as a means of further developing the natural resources of the province.

**VICTORIA.**—The Hardy Bay Coal Company here has been organized with a capital stock of \$1,000,000, with the object of acquiring, developing, operating, working and selling mines, mineral claims, mining properties and petroleum claims, and the treating, refining and marketing of mineral coal or oil therefrom.

## Manufacturers' Notes

**BRITISH REGULATION OF SULPHURIC ACID.**—Important orders have been issued from the British Ministry of Munitions bearing the date of May 29, 1917, regulating, in all respects, the manufacture and sale of sulphuric acid. The order, according to *Commerce Reports*, says that:

1. No person shall as on and from the 11th of June, 1917, until further notice, manufacture sulphuric acid except under a license issued by or under the authority of the Minister of Munitions and in accordance with the terms and conditions of such license as to the quantities to be manufactured or otherwise.



2. No person manufacturing sulphuric acid shall as on and from the 11th of June, 1917, until further notice, use during any one calendar month more than 10 tons in all of 95 per cent sulphuric acid (or its equivalent in acid of other strengths) for the purpose of all other manufactures, trades and businesses carried on by him except under and in accordance with the terms and conditions of a license issued by or under the authority of the Minister of Munitions.

3. No person shall as on and from the day following the date of this order, until further notice, supply sulphuric acid (including waste sulphuric acid) to any person except under and in accordance with the terms and conditions of a license issued by or under the authority of the Minister of Munitions. Provided that no license shall be required to supply not more than 56 pounds of 95 per cent sulphuric acid (or its equivalent in acid of other strengths) to any person during any one calendar month. And provided also that any sulphuric acid supplied subsequently to the date of this order in pursuance of written directions or requests given or made by or on behalf of the Minister of Munitions previously to the date of this order shall, unless and until such written directions or requests are canceled or withdrawn, be deemed to have been supplied under a license issued under the authority of the Minister of Munitions within the meaning of this order.

The order also states that no manufacturer of sulphuric acid or agent of such a manufacturer shall charge or receive in payment for any sulphuric acid supplied by or through him a price exceeding a maximum specified in the order.

**NATIONAL ANILINE & CHEMICAL COMPANY, INC., ELECTS OFFICERS.**—The officers and directors of the new National Aniline & Chemical Company, chosen at the recent meeting, are as follows:

Chairman of the Board, William H. Nichols; president, J. F. Schoellkopf; first vice-president, William Beckers; second vice-president and treasurer, I. F. Stone; third vice-president, Hugo Schoellkopf; and secretary, William T. Miller. The directors are J. F. Schoellkopf, J. F. Schoellkopf, Jr., Hugo Schoellkopf, all of the Schoellkopf Aniline & Chemical Works, Inc.; William Beckers, Eugene Meyer, Jr., Charles J. Thurnauer of the W. Beckers Aniline & Chemical Works, Inc.; William H. Nichols, Henry Wigglesworth and J. M. Goetchius of the General Chemical Company and Benzol Products Company; T. M. Rianhard and W. N. McIlravy of Barrett Company and Benzol Products Company; H. H. S. Handy and E. L. Pierce of Semet-Solvay Company and Benzol Products Company. Mr. Meyer and Mr. Thurnauer also represent the firm of Eugene Meyer, Jr., & Co., and I. F. Stone the National Aniline & Chemical Company.

The capacity of the company will be more than 30,000,000 pounds annually, and expansions are going on rapidly. The offices have been at 244 Madison Avenue since July 1.

**DU PONT'S MAY ENTER DYESTUFF FIELD.**—The Du Pont company is planning to enter the coal tar dye industry. The company has been investigating the dye situation for a long time. Its chemists were at work before the war, and when the foreign supply was cut off their efforts were redoubled. The Du Pont company has adequate laboratory facilities and large plants already equipped, so that delay for building operations is unnecessary.

**VEGETABLE OIL INDUSTRY OF UNITED STATES.**—Director Samuel L. Rogers of the Bureau of the Census has issued a summary showing the production in the United States of edible vegetable oils other than cottonseed for the calendar year 1916.

There were received reports of 112 concerns in the United States in 1916 which manufactured 262,558,661 lb. of oil from peanuts, mustard seed, kapok seed, rape seed, sunflower seed, soya beans, walnuts, corn, copra, palm kernels, and olives. The movement to grow soya beans, peanuts and other oil-bearing seeds and nuts other than cottonseed for the manufacture of oil has received a great impetus and there will probably be several hundred establishments engaged in crushing the crops grown in 1917.

In addition to the production of domestic vegetable oils, which may be used for edible purposes, considerable quantities are also imported. During the calendar year 1916 there was imported 64,349,308 lb. of coconut oil, 16,597,785 lb. of cottonseed oil, 145,409,269 lb. of soya-bean oil, 29,270,063 lb. of palm oil, 4,323,735 lb. of palm-kernel oil, 2,089,861 gal. of peanut oil, 2,690,755 gal. of rape-seed oil, 7,686,593 gal. of Chinese-nut oil, and 7,382,353 gal. of edible olive oil. During the same period there was exported 188,213,816 lb. of do-

mestic cottonseed oil, and 9,118,812 lb. of corn oil; also 478,438 lb. of foreign coconut oil, 2,062,900 lb. of soya-bean oil, 56,805 lb. of palm oil, 22,780 gal. of peanut oil, and 52,263 gal. of edible olive oil.

**TO ASSURE SUPPLIES OF PALM OIL.**—A meeting was held at the Bureau of Foreign and Domestic Commerce in Washington last week which was attended by representatives of the tin-plate makers, soap makers, and palm oil importers, to arrange for an ample supply of palm oil for American industries.

A committee will be formed and the palm oil will be shipped direct from the west coast of Africa to the United States, instead of first going to England. In return for permitting exportation of oil, Great Britain is to receive its equivalent in glycerine content, which is 6 per cent.

**THE GREAT WESTERN SMELTING & REFINING COMPANY** of St. Louis has opened a Denver office at 312 Century Building, Denver, Col., their representative being Maxwell M. Levy. Orders will be taken from the Denver office and the shipments made either from the Chicago or St. Louis plants. The products offered by this company are: Babbitt, solder, pig lead, tin, antimony, copper ingot, brass ingot, aluminum ingot, phosphor tin, phosphor copper, stereotype, linotype, electrotype and monotype.

**SODIUM NITRATE.**—Marden, Orth & Hastings Company, Inc., of 61 Broadway, New York, are sole selling agents of the American Nitrogen Products Company, who are making sodium nitrate by the fixation of atmospheric nitrogen.

**NEW CHICAGO RESEARCH LABORATORY.**—The Research Laboratory of Chicago has recently been incorporated. This is an Illinois corporation, having a stock of \$50,000. It is organized for the purpose of carrying on research work in the development and exploitation of chemical processes. The company also expects to engage in the manufacture of some pharmaceutical and photographic chemicals. The incorporators are W. S. Shaw, H. McCormack, A. G. Wackenreuter of Chicago, George S. Rice of Petosky, Mich.; F. S. Howse of Boston, and E. C. Klipstein of New York. Mr. Klipstein is president of the company, and Mr. McCormack will act as manager.

**CARLISLE, PA., WANTS CHEMICAL INDUSTRIES.**—Manufacturers about to enter the chemical field for the manufacture of dyes and other chemical products will be interested in an announcement received from the Carlisle Chamber of Commerce at Carlisle, Pa., that their city is making a very strenuous effort to secure the location of desirable chemical enterprises. The peculiar atmospheric conditions existing in Carlisle have been determined by expert engineers employed by the Chamber of Commerce as adaptable in every respect for the chemical industry.

In addition to the natural facilities, free factory sites, financial assistance, and a very low electric rate of \$.011 per k.w.h. one of the lowest rates in the State of Pennsylvania, competent employees of all grades can be secured in Carlisle, and with its location in the Baltimore Freight Classification, situated on two railroads, is one of the most advantageously located cities for distribution of chemicals in southeastern Pennsylvania.

**NEW ELECTRIC FURNACE COMPANY.**—The Booth-Hall Company has been formed to conduct an electric furnace building, engineering and metallurgical business, with offices at 565 West Washington Blvd., Chicago. The new company is composed of five former officers and employees of the Snyder Electric Furnace Company: Mr. C. H. Booth, formerly president of the Snyder Electric Furnace Company, Chicago, will be president and general manager of this new company. Mr. W. K. Booth, formerly vice-president of the Snyder Electric Furnace Company, and who for many years was in charge of the engineering and metallurgical work for that company, is to be metallurgist for the new company. Mr. Julius R. Hall, formerly secretary, mechanical engineer and production manager of the Snyder Electric Furnace Co., will be vice-president of the new company and have charge of similar work for them. Mr. Hall was for many years designing engineer of the Strauss Basculle Bridge Company, Chicago. Mr. W. D. Walker, formerly sales manager of the Snyder Electric Furnace Company, will be sales manager of the new company, and Mr. F. J. Sheldon, formerly auditor of the Snyder Electric Furnace Co., will be secretary.

The company has applied for patents on an electric furnace to be called the Booth-Hall electric furnace. This will be de-

signed in three different types to suit the metallurgical conditions of the individual customer and to operate either one, two or three phase, as will best work out in each case. It is the intention of the new company to make a special study of the needs of its customers, and to be in a position to recommend the type of equipment best suited for the work to be done.

Experience has shown that frequently a three-phase furnace will work to better advantage on certain grades of steel than single phase, and other times a simple single-phase type of equipment is to be preferred.

The company has already closed a contract for a four-ton, two-phase, Booth-Hall furnace, which is to be the first unit in a newly formed electric steel company.

**THE INDUSTRIAL ELECTRIC FURNACE COMPANY**, organized under the laws of the State of Indiana, has acquired the business of the Snyder Electric Furnace Company and the Snyder patents and designs of electric furnaces and processes. The directors of the new company are Charles B. Sommers, Stoughton A. Fletcher and Charles B. Fletcher of Indianapolis and F. Von Schlegell and F. T. Snyder of Chicago. The business organization is new and the company will start with a large engineering force and will take up the manufacture of electric furnaces for steel work, will enlarge the plant at Clearing both for electro-metallurgical developments and for the commercial production of electric furnace products. Mr. Snyder, who will be interested in and associated with the new company as engineer and metallurgist, has had many years of experience in the electric furnace field. The executive officers of the company will be F. Von Schlegell, president, and Charles B. Fletcher. The offices of the new company will be at 53 West Jackson Boulevard.

## Manufacturers' Catalogs

**THE STIMPSON EQUIPMENT COMPANY**, Salt Lake City, Utah, has issued an attractive catalog on the Janney flotation machine for the treatment of ores by the flotation process. This booklet describes two types of Janney flotation machines and is illustrated by diagrams of the machines showing the different parts and also machines installed in different plants.

**THE UNION SWITCH & SIGNAL COMPANY**, Swissvale, Pa., has issued Bulletin 87 describing its forge plant.

**THE JAMES ORE CONCENTRATOR COMPANY**, 35 Runyon Street, Newark, N. J., has issued Bulletin No. 1, Section A, describing its concentrating tables.

**THE PREST-O-LITE Company**, Indianapolis, Ind., has issued a new catalog describing its apparatus for oxy-acetylene welding and cutting.

## Other New Publications

**MOTOR GASOLINE: PROPERTIES, LABORATORY METHODS OF TESTING AND PRACTICAL SPECIFICATIONS.** By E. W. Dean. This is a Bureau of Standards publication, Technical Paper, 166.

**THE ACTIVATED SLUDGE PROCESS OF SEWAGE TREATMENT.** By J. Edward Porter of the General Filtration Company, Rochester, N. Y. This book gives a bibliography of the subject, with brief abstracts, patents, news items, etc., compiled from current literature.

**MAGNETIC AND OTHER PROPERTIES OF IRON-ALUMINUM ALLOYS MELTED IN VACUO.** By Trygve D. Yensen and Walter A. Gateward. This is Bulletin No. 95 published by the University of Illinois, Urbana Engineering Experiment Station.

**LIST OF PUBLICATIONS OF THE DEPARTMENT OF COMMERCE AVAILABLE FOR DISTRIBUTION.** The fifteenth edition of this book, issued May 8, 1917.

**THE MINING INDUSTRY IN THE TERRITORY OF ALASKA DURING THE CALENDAR YEAR 1915.** By Sumner S. Smith. Bulletin 142 issued by the Department of the Interior, Bureau of Mines.

**THE COAL-FIELDS AND COAL INDUSTRY OF EASTERN CANADA.** By Francis W. Gray, Bulletin No. 14, published by the Canadian Department of Mines, Ottawa.

**ANNUAL REPORT OF THE MINERAL PRODUCTION OF CANADA DURING THE CALENDAR YEAR 1915,** published by the Canadian Department of Mines, Mines Branch, Ottawa.